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BETTER FRUIT

APRIL 1911—IRRIGATION EDITION

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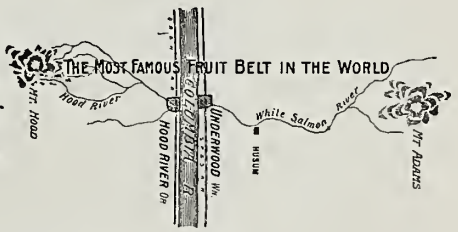

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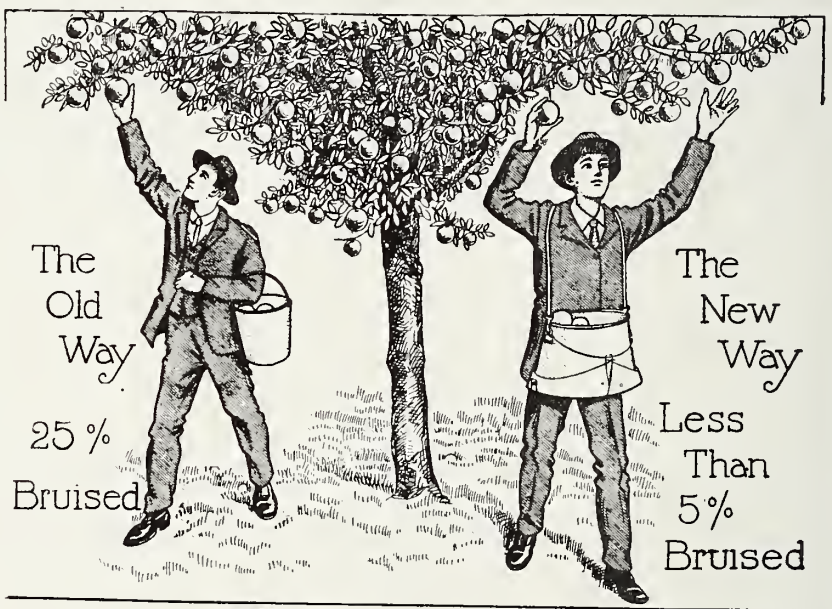

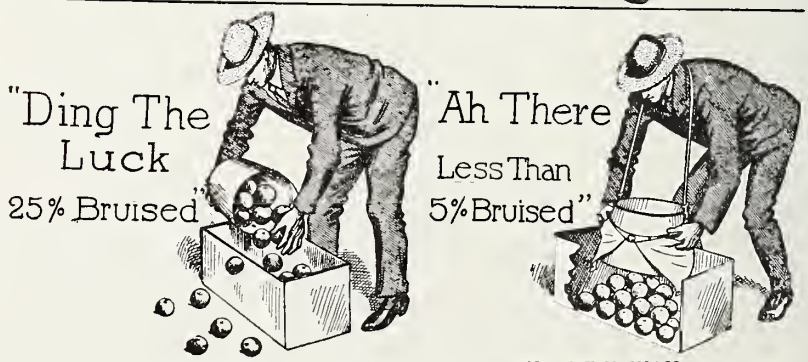

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BETTER FRUIT

A MONTHLY ILLUSTRATED MAGAZINE PUBLISHED IN THE INTEREST OF MODERN AND PROGRESSIVE FRUIT GROWING AND MARKETING

SCIENTIFIC METHOD OF IRRIGATING ORCHARDS

BY SAMUEL FORTIER, CHIEF OF IRRIGATION INVESTIGATION, EXPERIMENTAL STATION, U. S. DEPARTMENT OF AGRICULTURE

CARE and good judgment should be exercised in the selection of an orchard tract. If it turns out well the profits are high, but if it fails the losses are heavy. It involves the setting aside of good land, the use of irrigation water, and somewhat heavy expense in purchasing trees, setting them out and caring for them until they begin to bear.

Assuming that the climate and soil of the district selected are adapted to the kind of trees to be grown, the next important things to consider are good drainage and freedom from early and late frosts. Low-lying lands under a new irrigation system should be regarded with suspicion, even if the sub-soil be quite dry at the time of planting. The results of a few years of heavy and careless irrigation on the higher lands adjacent may render the low lands unfit for orchards. On the other hand, the higher lands are not always well drained naturally. A bank of clay extending across a slope may intercept percolating water and raise it near the surface. Favored locations for orchards in the mountain states are often found in the narrow river valleys at the mouths of canyons. The coarse soil of these deltas, the steep slopes and the daily occurrence of winds, which blow first out of the canyons and then back into them, afford excellent conditions for the production of highly flavored fruits at the minimum risk of being injured by frost.

Proper exposure is another important factor. In the warmer regions of the West and Southwest a northern exposure is sometimes best, but as a rule the orchards of the West require warmth and sunshine, and a southerly exposure is usually most desirable. Natural barriers frequently intercept the sweep of cold, destructive winds, and when these are lacking wind-breaks may be planted to serve the same purpose. Depressions or sheltered coves should be avoided if the cold air has a tendency to collect in them, a free circulation of air being necessary to drive away frost. The low-lying lands seem to be the most subject to cold, stagnant air.

While experience has shown that the orchard trees of nearly all kinds can be successfully grown on soils that differ widely in their mechanical and chemical composition it has also shown that certain types of soils are best adapted to particular kinds of trees. Thus the best peach, almond, apricot and olive orchards of the West are found on the lighter or sandier loams; the best apple, cherry and pear orchards on heavier loams, while walnut, prune and orange orchards do best on medium grades of soil. The requirements of all, however, are a deep, rich and well drained soil.

Formerly most Western orchards were supplied with water through earthen ditches. These leaky, unsightly channels, by reason of their cheapness, would have been quite generally retained had it not been for the increasing value and scarcity of water. The value of water for irrigation purposes has increased beyond the average of that given by the census report of 1902 over 300 per cent. In many localities there is likewise great scarcity at certain times. These rapidly changing conditions have induced many water companies to save some of their heavy losses in conveying water supplies by substituting pipes for open ditches in earth, or else by making the ditches water tight by an impervious lining.

The high value and scarcity of the water in natural streams have likewise induced orchardists to install pumping plants to raise water from underground sources. It was estimated that in 1909 20,000 of these plants were in operation in California alone. In other parts of the West reservoirs are being built to supplement the late summer flow of streams which fail to provide enough water for all.

The few typical examples which follow may not only give the reader an idea of how orchards are supplied with water, but also indicate the customary division into tracts to serve this and other purposes.

Contents

The Lewiston Basin is located where Clearwater River flows into the Snake River in Western Idaho, and varies from 700 to 1,900 feet above sea level. A few years ago water was brought from neighboring creeks and stored in a reservoir. The water required for orchard irrigation is conducted from this reservoir under pressure in two lines of redwood stave pipes over the rolling hills which separate the reservoir from the orchard lands. On these lands contour lines were first established, and each quarter section was afterwards divided into forty-acre tracts by sixty-foot streets. These were further subdivided into eight five-acre tracts, with a twenty-foot alley through the center. Figure 1, showing block 28 of the survey, indicates the general arrangement. The large conduits from the reservoir are connected to smaller lateral pipes laid in the alleys, and these in turn are tapped by three-inch pipes, which furnish water to the five-acre tracts.

The town of Corona, California, is hemmed in on all sides by lemon and orange orchards. The chief water supply for these groves comes from Perris Basin, forty miles distant. The Temescal Water Company owns 3,600 acres of water-bearing lands in this basin, and at favorable points pumping plants have been installed. These plants are operated by motors supplied with current from a central generating station located at Ethenac. The discharge from each pump is measured over a rectangular wier having an automatic register. This device is shown in Figure 2. Small lined channels convey the water from the pumps to the main conduit, shown in cross-section in Figure 3. The concrete lining of this conduit is composed of one part cement to seven parts sand and gravel, having a thickness on the slopes of two and one-half inches and on the bottom of three to four inches. The lining is rendered still more impervious by the addition of a plaster coat one-fourth of an inch in thickness, composed of one part of cement to two parts of sand. The cost was five and one-half cents per square foot, or fifty-five cents per linear foot. The main conduit consists of about thirty miles of lined canal and ten miles of piping thirty inches in diameter. The groves are laid out as a rule in ten-acre tracts, and piping of various kinds conveys the water from the main to the highest point of each tract, from which it is distributed between the rows in furrows.

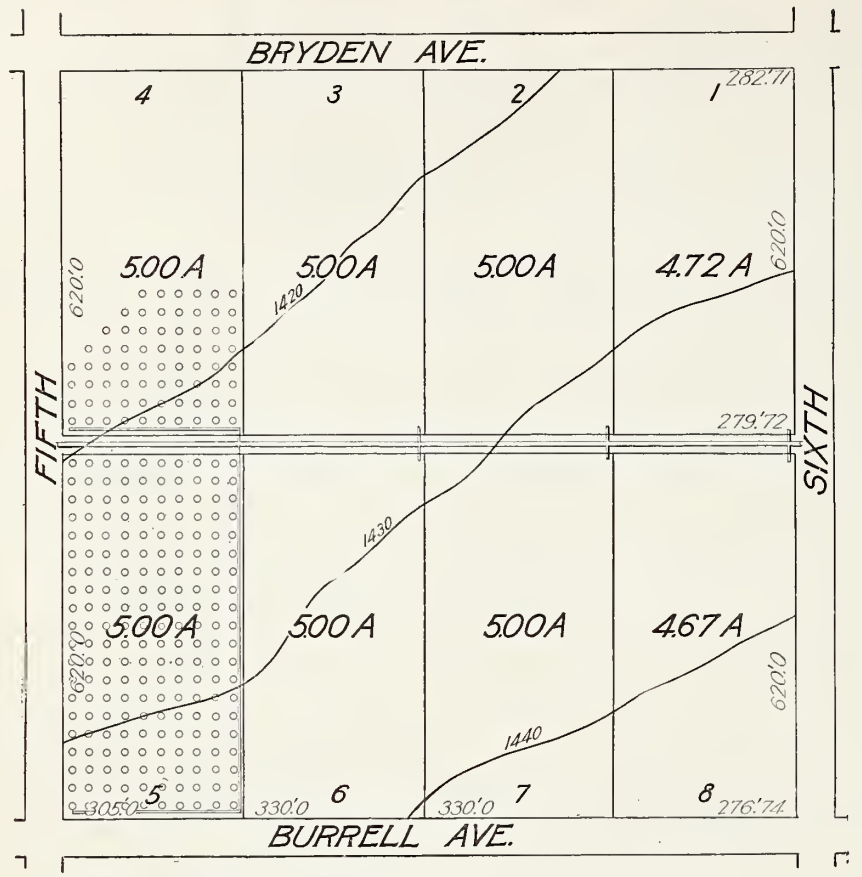


FIGURE 1—ORCHARD TRACTS AT LEWISTON, IDAHO

A large part of the water used by the Riverside Water Company is pumped from the gravelly bed of the Santa Ana River. From thence it is conveyed in a main canal to the orchard lands and distributed to the groves in cement and vitrified clay pipes. The owner of a tract, whether it be ten, twenty, thirty or forty acres in extent, receives his supply at the highest corner through a hydrant box. Each hydrant box not only allows the water to pass from the end of a lateral pipe to the head flume of the tract to be irrigated, but also measures the amount in miner's inches under a four-inch pressure head as it passes through. A section of the hydrant box, showing the adjustable steel slides to regulate the opening, is given in Figure 4.

On the Gage canal system in Riverside, California, the water supply for the tiers of forty-acre tracts is taken from the canal in riveted steel pipes, varying from six to ten inches in diameter. These larger mains are connected with four, five and six-inch lateral pipes of the same material, which convey the water to the highest point of each ten-acre tract. This general arrangement is shown in the sketch, Figure 5.

As a rule fruit trees are planted on land previously cultivated and cropped. One of the best preparatory crops for orchards is alfalfa. This vigorous plant breaks up the soil and sub-soil by its roots, collects and stores valuable plant foods, and when it is turned under at the end of the second or third year leaves the soil in much better condition for the rentention of moisture and the growth of young trees.

In the Bitter Root Valley, Montana, new land is first plowed eight to twelve inches deep, then carefully graded and smoothed and seeded to red clover for one or two seasons. On the west side of this valley pine trees and pine stumps are encountered. These can best be removed by burning. A hole one and one-half inches in diameter is bored through the base of the stump or tree in a slanting direction. It is near the surface of the ground on the windward side and about eighteen inches above the surface on the leeward side. A fire is then built in the hole, using small twigs to start it. As the fire burns the opening is increased and larger limbs are inserted. In two or three days the stump will have burned out, the fire burning down into the roots to a depth of twelve to fourteen inches. The cost of such clearing varies with the character of the land and the density of the growth. From $10 to $15 an acre will clear the land of stumps, and it then costs $5 to $10 to get the unburnt roots plowed out and the land ready for planting.

In recent years large areas of wooded lands in both the Hood River and Rogue River Valleys of Oregon have been cleared in order to plant apple trees. One of the methods employed in the Hood River district to rid the land of its growth of fir, pine, scrub oak and laurel is similar to that just described. Another method consists in splitting open the stumps with giant powder and then pulling out the roots with a stump puller. Stump pullers of various kinds are used in California for a like purpose. The most powerful of these consists of a portable engine, windlass and cable similar to an ordinary hoisting plant. A heavy chain is fastened to the tree at the proper height above the ground. To this chain the pulling cable is hooked, and when the power is applied the tree is pulled out by the roots.

In New Mexico and Texas the mesquite is usually grubbed out by Mexicans, but in California, where labor costs more, such shrubs as mesquite, manzanita and chaparral can be more cheaply removed by a stout pair of horses and a logging chain.

An effort should be made to establish a fairly uniform grade from top to bottom of each tract. This is done by cutting off the high points and depositing the earth thus obtained in the depressions. The length of the furrows should not exceed one-eigth of a mile, and in sandy soil they should be shorter. As a rule it is not difficult to grade the surface of an orchard so that small streams of water will readily flow in furrows from top to bottom.

In setting out orchards which are to be irrigated the elevation of the surface of the ground should first be ascertained. This is usually done by making a contour survey by which each tract is divided up into a number of curved strips or belts by level lines. Such contours are shown in Figure 1, the vertical distance between them in this particular case being one foot. With these as a guide the direction of the tree rows can readily be determined. Where the trees are watered in basins or checks flat slopes are not so objectionable, but in furrow irrigation a slope of about two inches to the one hundred feet is necessary to insure an even distribution of water. When streams are to be run in the furrows the slope of the furrows may be increased to eight, ten and even to twelve inches to the 100 feet. On slopes varying from ten to forty feet to the mile the tree rows may, therefore, be located at the proper distance apart down the steepest slope. Under such conditions the trees are most commonly planted in squares. The location of the trees can be best fixed by the use of a surveyor's transit and steel tape. When these are not available a woven wire cable about three-sixteenths of an inch in diameter will answer the purpose. If apple trees are to be set out, and it is desired to have them thirty-two feet apart tags are inserted between the strands of the cable to mark this exact distance. A base line at the proper distance from the fence or one margin of the field is then laid down and long sighting stakes driven at each tag. The corner is then turned and a similar line is laid out. This process is continued until the location of the trees around each of the four sides of the tract has been fixed. The corners can best be turned with a 100-foot tape or link chain.

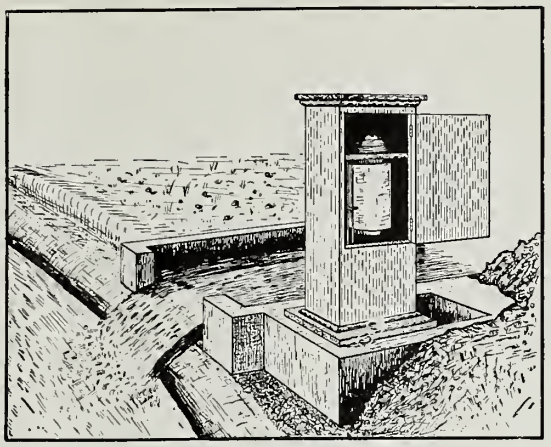


FIGURE 2—WEIR WITH AUTOMATIC REGISTER, USED BY THE TEMESCAL WATER COMPANY

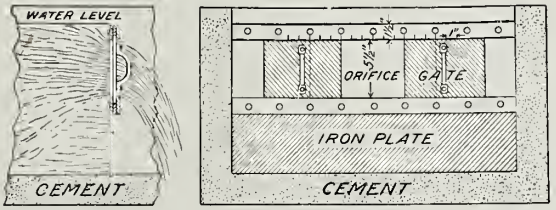


FIGURE 4—SECTION OF HYDRANT BOX, RIVERSIDE WATER COMPANY, SHOWING DEVICE FOR MEASURING MINER'S INCHES

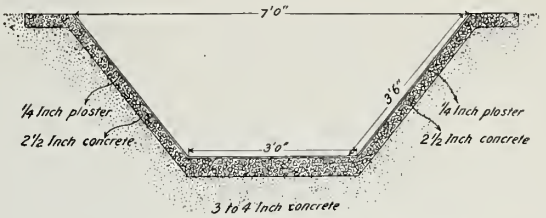


FIGURE 3—CONCRETE-LINED CANAL OF TEMESCAL WATER COMPANY

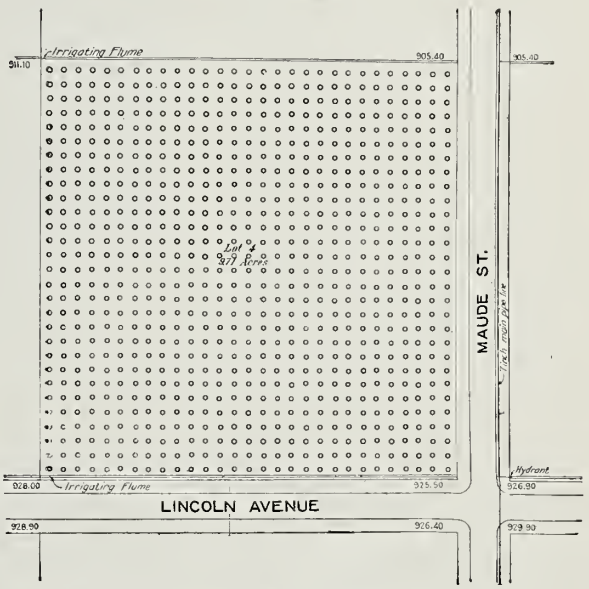


FIGURE 5—ORCHARD TRACT UNDER GAGE CANAL RIVERSIDE, CALIFORNIA

First measure from the end of the base line a distance of thirty feet. Hold the one hundred end of the chain at this point, and the ten-foot link at the corner; take the tape or chain at the fifty-foot mark or link and pull both lines taut. A stake driven at this vertex will establish a point on a line at right angles to the first. When stakes have been set on all four sides the intermediate locations for the trees can readily be ascertained by sighting between corresponding marginal stakes.

Where the slope is steep and difficulties are likely to be encountered in distributing water the equilateral, hexagonal or septuple method of planting, as it is variously termed, should be adopted. The manner of marking the ground for this method is indicated in Figure 6. It will be observed that in this method the ground is divided up into equilateral triangles, with a tree at each vertex. The trees likewise form hexagons, and when one includes the center tree at each hexagon they form groups of sevens. Hence the name equilateral, hexagonal and septuple.

The chief advantage of this mode of planting in irrigated districts is that it provides three, and often four, different directions in which furrows may be run. Having the choice of so many it is not difficult to select one which is best for any particular tract. The ground can likewise be cultivated in more ways, and about one-seventh more trees can be planted to a given area than is possible in the square method.

In the past the trees of irrigated orchards have been planted too close. This is made clear to even the casual observer who visits the old orange groves of Riverside, California, the deciduous orchards of the Santa Clara Valley, California, or the apple orchards of the Hood River district in Oregon. Under irrigation systems peach trees should be spaced twenty to twenty-two feet, olive, pear, apricot and cherry trees from twenty-two to twenty-eigth and thirty feet, orange trees twenty-two to twenty-four feet, apple trees thirty to thirty-six feet and walnut trees from forty-eight to fifty-six feet apart.

On the Pacific Coast the tendency toward wide spacing has induced many growers to insert peach fillers between other slower maturing trees, such as the apple and walnut. A common practice in this direction is shown in Figure 7, which represents the arrangement of trees in a young orchard in Douglas County, Washington. Here the trees are set in squares eighteen feet each way, but in every other row peach trees alternate with the standard apple trees. In the remaining rows Winesap apple trees are used for fillers. As the apple trees grow and begin to crowd the fillers the peach trees are removed. If more space is required the Winesaps can be taken out, leaving the apple trees in squares thirty-six feet apart both ways.

The usual way of irrigating orchards is by means of furrows. These vary in depth, length and distance apart, but this diversity does not tend to create different kinds of furrow irrigation. The division of this subject is rather due to the means employed in distributing the water from the supply ditch to the furrows. In some cases the distribution is effected by making openings in an earthen ditch, in others by inserting wooden or iron spouts in the ditch banks, while in many others flumes having the desired number of openings, or pipes with standpipes, divide the supply among the requisite number of furrows. These designs and methods will be described under their respective headings.

Permanent ditches at the head of orchard tracts should be located by a surveyor. The proper grade depends chiefly on the soil. If the soil is loose and easily eroded a slow velocity is best. On the other hand, the velocity must be sufficiently rapid to prevent the deposition of silt and the growth of water plants. In ordinary soils a grade of two and one-half inches to one hundred feet for a ditch carrying two cubic feet per second is not far out of the way. The amount of water to be carried varies from one-half to two or more cubic feet per second. A ditch having a bottom width of twenty-four inches, a depth of six inches and sloping sides ought to carry one and one-half cubic feet per second on a grade of half an inch to the

rod, or three inches to one hundred feet. Such a ditch may be built by first plowing four furrows and then removing the loose earth either with shovels or a narrow scraper. The loose earth may likewise be thrown up on the sides and top by means of the home-made implement shown in Figure 8. Canvas dams, metal tappoons or other similar devices are inserted in the head ditch to raise the surface of the water opposite that part of the orchard where furrows have been made, and which is about to be watered. The chief difficulty in this mode of furrow irrigation arises in withdrawing water from the ditch and in distributing it equally among a large number of furrows. A skilled irrigator may adjust the size and depth of the ditch bank openings so as to secure a somewhat uniform flow in the furrows, but constant attention is required in order to maintain it. If the water is permitted to flow for a short time unattended the distribution is likely to become unequal. Parts of the ditch bank become soft, and, as the water rushes through, the earth is washed away, permitting larger discharges and lowering the general level of the water in the ditch so that other openings may have no discharge. Some of the orchardists of San Diego, California, insert in niches cut in the bank pieces of old grain sacks or tent cloth. The water flows over these without eroding the earth. Another device is to use a board pointed at the lower end and containing a narrow opening or slot, through which the water passes to the furrow. Shingles are also used to regulate the flow in the furrows. The thin ends of these are stuck into the ground at the heads of furrows.

In recent years short tubes or spouts have been used in many of the head ditches of orchards to divert small quantities of water to furrows. These tubes are usually made of wood, but pipes made of clay, black iron, galvanized iron and tin are occasionally used.

For nurseries, and young trees especially, and also for mature trees, a cheap and serviceable tube may be made from pine lath, such as are used for plastering. The four-foot lengths are cut into two equal parts and four of these pieces are nailed together to form a tube. One of these tubes, when placed with its center two inches below the surface of the water in the head ditch, discharges nearly three-quarters of a miner's inch of water,

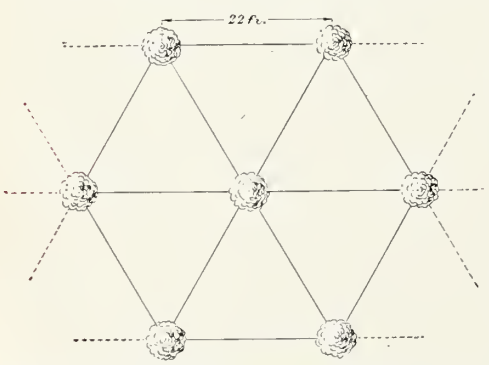


FIGURE 6—HEXAGONAL METHOD OF SETTING OUT ORCHARD TREES

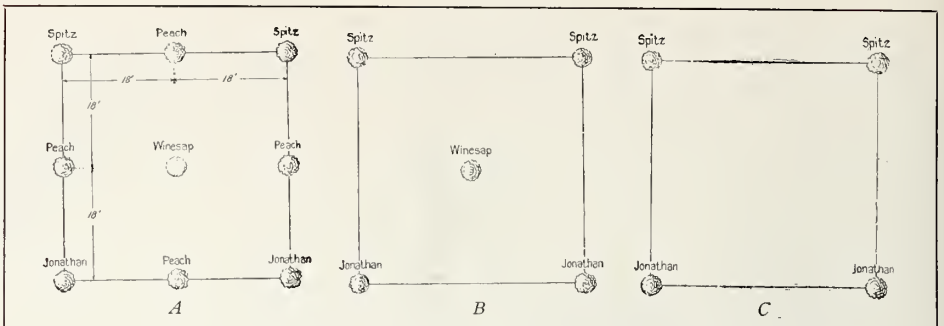


FIGURE 7—PLAN OF PLANTING APPLE TREES WITH PEACH TREES AS FILLERS
A, Trees as planted at first; *B*, Peach trees removed; *C*, Winesap removed.

and if placed four inches below the surface will discharge more than one miner's inch. In Southern Idaho the lumber mills manufacture a special lath for this purpose. It is one-half inch thick, two inches wide and thirty-six inches long. If such tubes, when thoroughly dry, are dipped in hot asphalt they will last a much longer time. In some of the deciduous orchards of California a still larger wooden tube or box is used. Figure 9 represents one of these. It is made of four pieces of three-quarter by three and three-quarter inch redwood boards of the desired length. The flow through this tube is regulated by a cheap gate, consisting of a piece of galvanized iron fastened by means of a leather washer and a wire nail.

The orchardist who lives near a manufacturing town or city can often purchase at a low figure pieces of worn-out and discarded piping, varying from three-quarters to two inches in diameter. Such pipes, when cut into suitable lengths, make a good substitute for wooden spouts. Tin tubes one-half inch in diameter and of the proper length have been used with good success. In compact soils, through which water passes very slowly, furrows must be near together, and under such conditions small tin tubes are to be preferred.

In making use of tubes of various kinds to distribute water to furrows it is necessary to maintain a constant head in the supply ditch. This is done by inserting checks at regular distances. These distances vary with the grade of the ditch, but 150 feet is not far from being an average spacing. In temporary ditches the canvas dam is perhaps the best check, but in permanent ditches it pays to use wood or concrete. An effective wooden check is shown in Figure 10. In this the opening is controlled by a flashboard, which may be adjusted so as to hold the water at any desired height and at the same time permit the surplus to flow over the top to feed the next lower set of furrows.

Formerly head flumes for orchards were built of wood, but the steady increase in the price of lumber and the decrease in the price of Portland cement have induced many fruit growers to use cement instead. When built of wood the length of the sections varies from twelve to twenty feet, sixteen feet being the most common. The bottom width runs from six to twelve inches, while the depth is usually one to two inches less. Redwood lumber one and one-quarter inches thick is perhaps the best for the bottom and sides, and joists of two by four-inch pine or fir are commonly used for yokes, which are spaced four feet centers. Midway between the yokes auger holes are bored, and the flow through these openings is controlled in the manner shown in Figures 11 and 12. A two-inch fall for each hundred feet may be regarded as a suitable grade for head flumes, but it often happens that the slope of the land is much greater than this, in which case low checks are placed in the bottom of the flume at each opening, as shown in Figure 12.

A head flume composed of cement, sand and gravel costs, as a rule, about twice as much as a wooden flume of the same capacity, but the early decay of wood, especially if it comes in contact with earth, makes the cement flume cheaper in the end. By means of a specially designed machine, which is patented, cement mortar, composed of one part cement to about six parts of coarse sand, is fed into a hopper and forced by lever pressure into a set of guide plates of the form of the flume. Such flumes are made in place in one continuous line across the upper margin of the orchard tract. After the flume is built, and before the mortar becomes hard, small tubes from three-quarters to one and one-half inches in diameter, the size depending somewhat on the size of the flume, are inserted in the side next the orchard. The flow through these tubes is regulated by zinc slides, shown in Figure 12. Flumes of this kind are made in five sizes, the smallest being six inches on the bottom in the clear and the largest fourteen inches.

At a slightly greater cost a stronger flume can be built by the use of molds. The increased strength is derived from a change in the mixture. In the machine-made flume the mixture of one part cement to five or six parts of sand is lacking in strength, for the reason that there is not enough cement to fill all the open spaces in the sand. In using molds medium sized gravel can be added to the sand, and the mixture resembles that of the common rich concrete. Such flumes can be built of almost any size from a bottom width of ten inches to one of forty inches, and from a depth of eight inches to one of twenty-four inches, but when the section is increased beyond about 240 square inches it pays better to slope the sides outward and adopt the

FIGURE 8—THE USE OF THE "A" SCRAPER IN BUILDING HEAD DITCHES

form of the cement lined ditch. At the present time the cost of rich concrete in place would be about $9 per cubic yard for the larger flumes and $10.50 for the smaller sizes. The quantity of concrete required per linear foot of flume depends on its size and the thickness of its sides and bottom. The dimensions given in Figure 13 are for light rather than for heavy flumes, and are designed for localities where there is little frost.

For large head flumes and laterals many fruit growers first carefully prepare an earthen ditch which has carried water for at least one season and afterwards line the inner surface with cement concrete. Figure 14 shows a section of such a ditch.

Several years ago 3,200 linear feet of head ditches were lined for twenty-six and one-half cents per foot; they were fourteen inches on the bottom, with eighteen-inch sides and a two-inch lining. The cement cost $2.85 per barrel, gravel seventy-five cents per yard and labor $1.75 to $2.50 per day.

Head flumes, being placed on the surface of the ground, interfere with the free passage of teams in cultivating, irrigating and harvesting the crop. Dead leaves from shade and fruit trees also clog the small openings in the flumes. These and other objections to flumes have induced many fruit growers of Southern California to convey the water in underground pipes and distribute it through standpipes placed at the heads of the rows of trees. Both cement and clay pipes are used for this purpose.

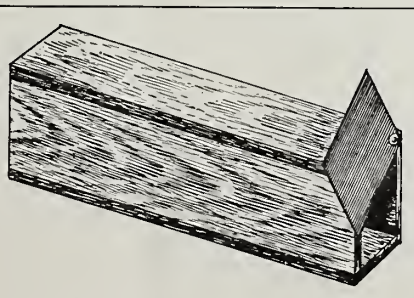


FIGURE 9—WOODEN BOX PLACED IN BANK OF HEAD DITCH

The former are usually molded in two-foot lengths, with beveled lap joints, and consist of a one to three or one to four mixture of cement and fine gravel and sand. The most common sizes are six, eight, ten and twelve inches in diameter, having a thickness of shell in the twelve-inch pipe of one and one-half inches, which is reduced to a trifle more than one inch in the six-inch pipe. Piping of this kind, when well made and carefully laid, will withstand a head of ten to sixteen feet. The clay pipe is similar to that used in cities for sewers and, having stronger joints, withstands a greater pressure, but costs more. A line of pipe is laid about two feet below the surface from the feed main and measuring box across the top of the orchard, and as each row of trees is passed a standpipe is inserted. The general plan is shown in outline in Figure 15. Various devices are employed to convey the water from the pipe to the surface of the ground at the head of each tree row and divide it up evenly among four to six furrows. One of the most common consists of a series of standpipes, the top of each set rising to the same elevation. At each change of elevation special standpipes are used, and in these are inserted gates provided with overflows. The manner of distributing the water from a standpipe to the furrows of any one row is shown in Figure 16.

Occasionally a high pressure pipe is substituted for cement and clay. This is tapped at the head and in line with each row of trees, and a small galvanized iron pipe is inserted. These standpipes are capped by an ordinary valve, which regulates the flow to each row of trees. This method is shown in operation in Figure 17, where a young orchard is being irrigated from three-quarter-inch galvanized iron standpipes connected with a thee-inch wooden pipe.

The length of the furrow is often governed by the size of the orchard. The rows of citrus trees seldom exceed forty rods in length, but the apple orchards of the Northwest are larger as a rule. Even in large tracts it is doubtful if it ever pays to run water in furrows more than about 600 feet. Where the soil is open and water sinks readily through it short furrows should be used, otherwise much water is lost in deep percolation on the upper part of the tract. Professor H. Culbertson, of San Diego County, California, after a careful investigation of this subject, has reached the conclusion that on sandy or gravelly soil having a steep slope the proper length of furrows is 200 feet, while on heavier soils and flatter slopes the length may be increased to 600 feet.

The grade of furrows varies quite widely. In flat valleys it is often not possible to obtain a fall greater than one inch to 100 feet, while on steep slopes the fall may reach twenty inches per 100 feet. On ordinary soils a grade of three to four inches is to be preferred, and where the fall exceeds eight to ten inches to 100 feet the trees should be set out in such a way as to decrease the slope of the furrows.

The number of furrows in orchards depends on the age of the trees, the space between the rows, the depth of furrow and the character of the soil. Nursery stock is irrigated by one or two furrows and young trees by two to four. A common spacing for shallow furrows is two and one-half feet, while deeper furrows are made three to four feet apart. The general trend of orchard practice is toward deep rather than shallow furrows, a depth of eight inches being frequently used.

The furrowing implement most commonly used by the orchadists of Orange County, California, consists of a sulky frame, to which are attached two or three double mold-board plows. Those who prefer a small number of deep furrows use a twelve to fourteen-inch corn lister. In Figure 18 is shown a furrower made by attaching an arm to a cultivator and then fastening two shovels to the arm. In the view the space between the furrows is four and one-half feet and

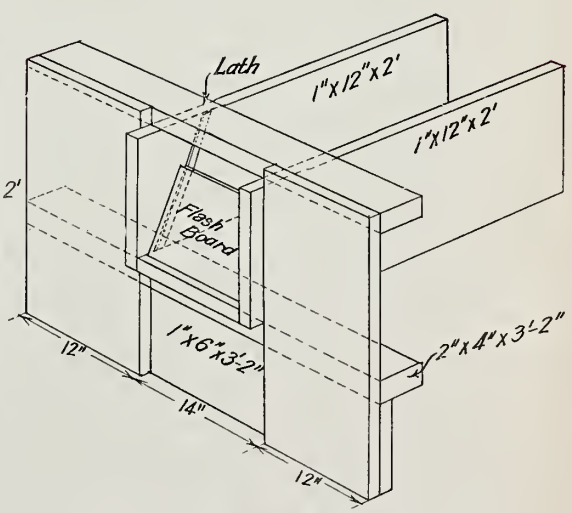


FIGURE 10—WOODEN CHECK IN HEAD DITCH

the depth is regulated by the lever arm of the cultivator.

In the Payette Valley, Idaho, 200 or more miner's inches are turned into the head ditch and divided up by means of wooden spouts into a like number of furrows. On steep ground much smaller streams are used. The length of the furrow varies from 300 feet on steep slopes to 600 feet and more on flat slopes. The time required to moisten the soil depends on the length of the furrow and the nature of the soil. In this locality it varies from three to thirty-six hours.

J. H. Foreman owns twenty acres of bearing orchard under the Sunnyside canal in the Yakima Valley, Washington, and waters it four times in each season with fourteen miner's inches (0.35 cubic feet per second). He makes three furrows between the rows, which are forty rods long. The total supply is applied to one-half the orchard (ten acres) and kept on forty-eight hours.

On the clayey loams of the apple orchards on the east bench of the Bitter Root River, Montana, Professor R. W. Fisher has found, as a result of experimenting, that it requires from twelve to eighteen hours to moisten the soil in furrow irrigation four feet deep and three feet sideways.

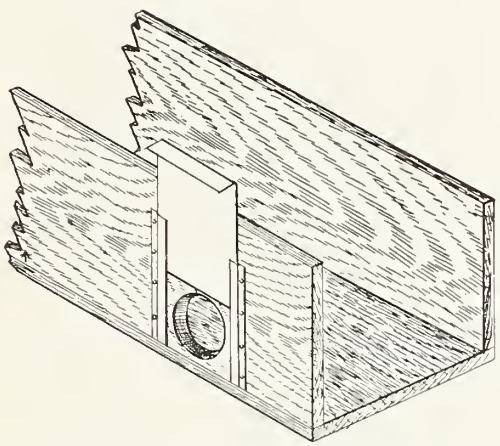


FIGURE 11—SECTION OF WOODEN HEAD FLUME SHOWING OPENING AND GATE

In 1908 Mr. Struck, of Hood River, Oregon, irrigated three acres of apple trees in furrows 350 feet long, spaced three feet apart. About a miner's inch of water was turned into each alternate furrow from a wooden head flume, Figure 11, and kept on for about forty-eight hours. After the soil had become sufficiently dry it was cultivated, and in eight or ten days thereafter water was turned into the alternate rows, which were left dry during the first irrigation.

For the most part the furrows are made parallel to the rows of trees. An arrangement of this kind is satisfactory in young orchards, but as the trees reach maturity their branches occupy more of the open space between the rows and prevent the making of furrows near the trees. This is shown in Figure 19, where a space of six to twelve feet square, according to the size of the trees, is not furrowed. This space usually becomes so dry that it is worthless as a feeding ground for roots. In order to moisten these dry spots a larger stream is often carried in the two furrows next to each row of trees and the surplus is led across in short furrows in the manner shown in Figure 20. Instead of continuing straight and cross furrows, as is done in Figure 20, use is frequently made of diagonal furrows, Figure 21, to moisten the dry space between the trees. This last method is best adapted to grades of five inches to the one hundred feet or more.

A method and the cost of one irrigation is described as follows:

The implement used to make furrows consists of three shovels attached to a beam which is mounted on a pair of low wheels. The driver sits on a riding seat, and by operating a lever can regulate the depth of the furrows. A man and two horses will furrow out ten acres in a day. For a distance of 150 feet from the top of the orchard the furrows are straight. They are then zigzagged to within sixty or seventy feet of the bottom, where the last three rows of trees are irrigated by basins which catch the surplus. In the case described the depth of furrow was six inches, length 800 feet and distance apart three feet. A head of fifty miner's inches (one cubic foot per second) was used on ten acres. The streams when first turned into the furrows averaged about two miner's inches, but as the water approached the lower end they were reduced to one miner's inch or less, and this flow was run in each furrow for twelve to twenty-four hours.

The items of cost for ten acres were: Making furrows and basins, $6.50; irrigating, $3; fifty inches of water twenty-four hours at forty cents an hour, $9.60; rent of water stock, $12; a total of $31.10.

Orchards are sometimes irrigated by first forming ridges midway between the rows in two directions at right angles to each other. This divides up the tract into a large number of squares with a tree in the center of each, as may be observed in Figure 22.

When the ground is hard or covered with weeds a disk plow is first run between the rows and then the loosened earth is formed into a ridge by a ridger. If the soil is light, sandy and free from weeds the disking is not necessary. Ridgers are made in various ways of both wood and steel, or some combination of both. A common kind is shown in Figure 23. It consists of two deep runners fourteen to eighteen inches high, two inches thick and six to eight feet long. These runners are shod with steel, which extends part way up the inner side. They are four to five feet apart at the front end and tapered to sixteen to twenty-four inches at the rear. The runners are held in position by cross pieces on top, a floor and straps of steel in the manner shown. The height of the ridges varies with the depth of water applied, which is from four to nine inches. The ridges should be several inches above the surface of the water when a basin is flooded.

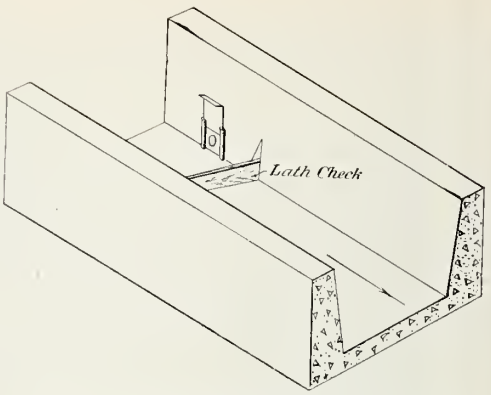


FIGURE 12—THE USE OF LOW CHECK IN HEAD FLUME

Several methods of flooding basins are practiced. In one a ditch is run from the supply ditch at the head through each alternate row space, and the basins on each side are flooded in pairs, beginning with the lowest. This plan is shown in outline in Figure 22. In the other method water is allowed to flow through openings into each basin of a tier in a zigzag course from the top to the bottom of the orchard. In this plan the upper basins receive the most water. Under gravity canals, where water is abundant, the water is turned into the upper basin until it is full, when it overflows into the next, and so on down the tier. The irrigator then begins at the lower end and repairs the breaks, leaving each basin full of water.

Where this method is practiced it frequently happens that land on which alfalfa has been grown is planted to fruit trees. In plowing down the alfalfa and setting out the trees the levees undergo little change, and the checks can be flooded if it is considered best. A better plan is to furrow the floor of each check, as shown in Figure 24. The water is admitted through the check box which was used for the alfalfa and conducted into a short head ditch, from which it is distributed to the furrows. The chief

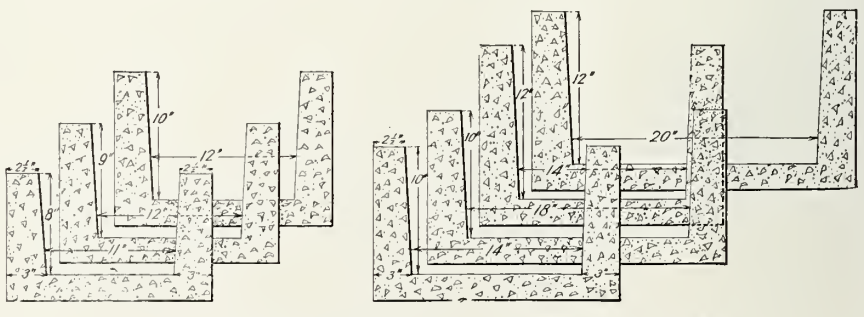


FIGURE 13—COMMON SIZES OF CONCRETE HEAD FLUMES

objection to this method is that the checks are too small for orchard tracts in furrow irrigation.

The best orchardists believe that frequent examinations of stems, branches, foliage and fruit are not enough. The roots and soil should likewise be examined. The advice of such men to the inexperienced is: Find out where the bulk of the feeding roots is located, ascertain the nature of the soil around them and make frequent tests as to the moisture which it contains. In a citrus orchard of sandy loam samples are taken at depths of about three feet, and the moisture content determined by exposing the samples to a bright sun for the greater part of a day. It is considered that six per cent by weight of free water is sufficient to keep the trees in a vigorous condition.

Doctor Loughridge, of the University of California, in his experiments at Riverside, California, in June, 1905, found an average of 3.5 per cent in the upper two feet and an average 6.16 per cent below this level in an orchard which had not been irrigated since October of the preceding year. It had received, however, a winter rainfall of about sixteen inches. On examination it was found that the bulk of the roots lay between the first and fourth foot. In June these trees seemed to be merely holding their own. When irrigated on July 7 they began to make new growth. A few days after the water was applied the percentage of free water in the upper four feet of soil rose to 9.64 per cent. The results of these tests seem to indicate that the percentage by weight of free moisture should range between five and ten per cent in orchard loams.

Many fruit growers do not turn on the irrigation stream until the trees begin to show visible signs of suffering, as a slight change in color or a slight curling of the leaves. In thus waiting for these signals of distress both trees and fruit are liable to be injured. On the other hand, the man who ignores these

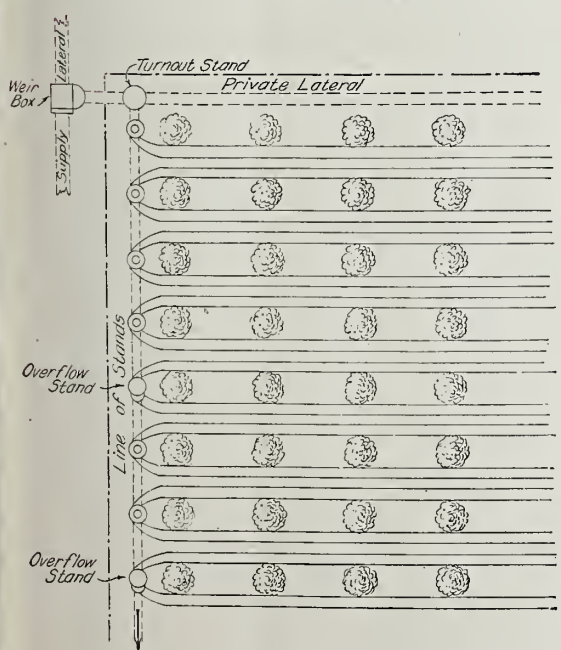


FIGURE 15—USE OF PIPES IN FURROW IRRIGATION

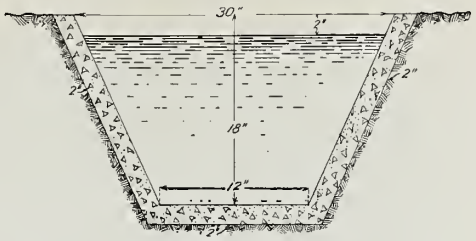


FIGURE 14—EARTHEN HEAD DITCH LINED WITH CONCRETE

symptoms and pours on a large quantity of water whenever he can spare it, or when his turn comes, is apt to cause greater damage by an overdose of water.

For nearly half the entire year the fruit trees of Wyoming and Montana have little active, visible growth, whereas in the citrus districts of California and Arizona the growth is continuous. A tree when dormant gives off moisture, but the amount evaporated from both soil and tree in winter is relatively small, owing to the low temperature, the lack of foliage and feeble growth. A heavy rain which saturates the soil below the usual covering of soil mulch may take the place of one artificial watering, but the light shower frequently does more harm than good. The number of irrigations likewise depends on the capacity of the soil to hold water. If it readily parts with moisture light but frequent applications will produce the best results, but if it holds water well a heavy application at longer intervals is best, especially when loss by evaporation from the soil is prevented by the use of a deep soil mulch.

In the Yakima and Wenatchee fruit growing districts of Washington the first irrigation is usually given in April or early in May. Then follow three to four waterings at intervals of twenty to thirty days. At Montrose, Colorado, water is used three to five times in a season. At Payette, Idaho, the same number of irrigations is applied, beginning about June 1 in ordinary seasons, and repeating the operation at the end of thirty-day intervals. As a rule the orchards at Lewiston, Idaho, are watered three times, beginning about June 15. From two to four waterings suffice for fruit trees in the vicinity of Boulder, Colorado. The last irrigation is given on or before September 5, so that the new wood may have a chance to mature before heavy freezes occur. In the Bitter Root Valley, Montana, young trees are irrigated earlier and oftener than mature trees. Trees in bearing are, as a rule, irrigated about July 15, August 10 and August 20 of each year. In San Diego County, California, citrus trees are watered six to eight times and deciduous trees three to four times in a season.

The duty of water for one acre as fixed by water contracts varies all the way from one-fortieth to one four-hundredth of a cubic foot per second. In general the most water is applied in districts that require the least. Wherever water is cheap and abundant the tendency seems to be to use large quantities, regardless of the requirements of the fruit trees. In Wyoming the duty of water is seldom less than at the rate of a cubic foot per second for seventy acres. In parts of Southern California the same quantity of water not infrequently serves 400 acres, yet the amount required by the fruit trees of the latter locality is far in excess of that of the former.

In recent years the tendency all over the West is toward a more economical use of water, and even in localities where water for irrigation is still reasonably low in price it is rare that more than two and one-half acre feet per acre is applied in a season. This is the duty provided for in the contracts of the Bitter Root Valley Irrigation Company of Montana, which has 40,000 acres of fruit lands under ditch. Since, however, the water user is not entitled to receive more than one-half of an acre foot per acre in any one calendar month it is only when the growing season is long and dry that he requires the full amount.

In the vicinity of Boulder, Colorado, the continuous flow of a cubic foot per second for 105 days serves about 112 acres of all kinds of crops. This amount of water, if none were lost, would cover each acre to a depth of 1.9 feet. In other words, the duty of water is a trifle less than two acre feet per acre.

In 1908 the depth of water used on a twenty-one and a half acre apple orchard at Wenatchee, Washington, was meas-

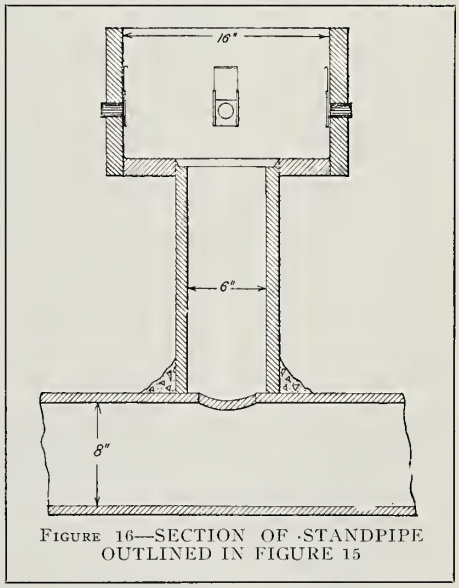


FIGURE 16—SECTION OF STANDPIPE OUTLINED IN FIGURE 15

ured and found to be twenty-three inches The trees were seven years old, and produced heavily. This orchard was watered five times, the first on May 13 and the last on September 23. In San Diego County, California, one miner's inch (one-fiftieth of a cubic foot per second) irrigates from six to seven acres near the coast, where the air is cool and evaporation low, but twenty miles or so inland the same amount of water is needed for about four acres.

On the sandy loam orchards of Orange County, California, it has been demonstrated that two acre inches every sixty days is insufficient to keep bearing trees in good condition. The rainfall of this locality averages somewhat less than twelve inches per annum, but about

ninety-five per cent of the total falls between November and May, inclusive.

The most reliable, and in many ways the most valuable, records pertaining to duty of water on orchards have been obtained by the water companies of Riverside County, California. Here more or less irrigation water is used every month of the year. Figure 25 is a graphic representation of the average amount of water used per month in a period of seven years by the Riverside Water Company in irrigating about 9,000 acres, of which nearly 6,000 acres are planted to oranges and the balance to alfalfa. The figures given in the diagram represent depth in feet over the surface watered. In the following table is given the average duty of water per month in acre feet per acre under the same system from December 1, 1901, to November 30, 1908, a period of seven years. The table also includes the average monthly rainfall at Riverside, California, for the same period, and adding the quantity of water applied in irrigation in any one month to the rainfall of that month gives the total moisture received by the soil:

Month	*Average depth per acre* Feet	*Average rainfall* Feet	*Total water applied* Feet
December	0.159	0.109	0.268
January	.123	.170	.293
February	.046	.190	.236
March	.078	.316	.394
April	.177	.068	.245
May	.291	.023	.314
June	.274	.003	.277
July	.272	.002	.274
August	.269	.000	.269
September	.243	.015	.258
October	.189	.043	.232
November	.169	.073	.242
Totals	2.29	1.01	3.30

A light shower followed by warm sunshine may refresh the foliage of fruit trees, but its effect on the soil is more likely to be injurious than otherwise. A brief, pelting rain followed by sunshine forms a crust on the surface of most soils, and if this is not soon broken up by cultivation it checks the free circulation of air in the soil, and also tends to increase the amount of water evaporated.

FIGURE 17—METHOD OF IRRIGATING FROM IRON STANDPIPES CONNECTED WITH PRESSURE PIPES

It has been found that the amount of moisture held by the soil, the temperature of both soil and air, and the rate of wind motion are the chief factors in the evaporation of water from soils. The influence of moisture is shown in the following figures, obtained from tank experiments made at Tulare, California, covering the period from June 15 to September 15, 1904:

	Amount of water applied Inches	*Loss by evaporation* Inches	Per cent
Tanks 1 and 2	0.0	0.45	....
Tanks 3 and 4	3.3	3.5	106.0
Tanks 5 and 6	4.9	4.6	94.0
Tanks 7 and 8	6.6	5.5	83.6
Tanks 9 and 10	8.2	6.6	80.0
Tanks 11 and 12	9.8	7.9	79.5

The results of other experiments have shown that when the water is applied to the surface of orchard soils the loss by evaporation is very great so long as the top layer remains moist. Even in light irrigations this loss in forty-eight hours after the water is put on may amount to from ten to twenty per cent of the volume applied. In order to reduce this loss and moisten the soil around the roots of trees the practice of running small streams of water in deep furrows has become quite common. In applying water in this way the top soil remains at least partially dry, the bulk of the water soon passes beyond the first foot, and the surface can be cultivated soon after the water is turned off.

The well known effect of temperature on evaporation is shown in Figure 26. The dotted line shows the mean monthly temperatures at Tulare, California, from January 1, 1904, to December 31, 1905, and the solid line the monthly evaporation from a water surface for the same time.

The effect on evaporation of a layer of dry granular soil when placed above moist soil has been shown by a series of experiments conducted in tanks by irrigation investigations of this office. These tanks are water-jacketed and placed in the open under normal conditions as regards sunshine, wind and temperature. Each tank holds about three-fourths of a ton of soil, and is weighed at stated intervals in a manner shown in Figure 27. The results of experiments made at Davis, California, in 1908 were as follows:

Tanks 1 and 2, no mulch—Average weight of tanks September 1, 1,104.7 pounds; total loss for 32 days, September 1 to October 3, 33.25 and 35.93 per cent.

Tanks 3 and 4, 3-inch mulch—Average weight of tanks September 1, 1,090 pounds; total loss for 32 days, September 1 to October 3, 14.25 and 15.17 per cent.

Tanks 5 and 6, 6-inch mulch—Average weight of tanks September 1, 1,082 pounds; total loss for 32 days, September 1 to October 3, 5.75 and 6.12 per cent.

Tanks 7 and 8, 9-inch mulch—Average weight of tanks September 1, 1,085.2 pounds; total loss for 32 days, September 1 to October 3, 0.75 and 0.80 per cent.

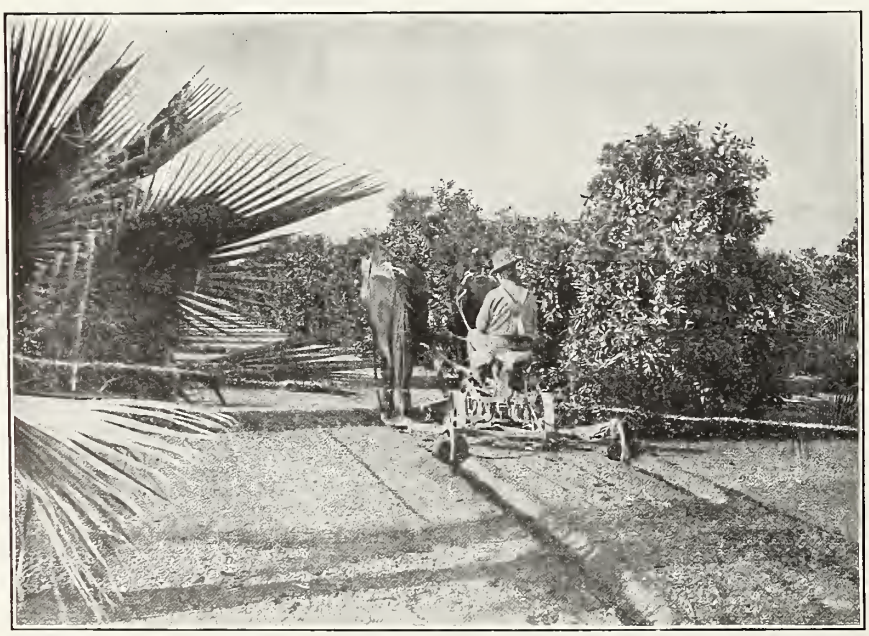


FIGURE 18—MAKING FURROWS IN ORCHARD

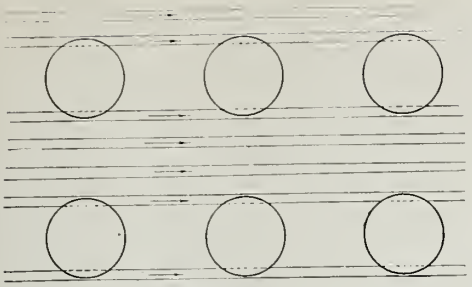


FIGURE 19—FURROW IRRIGATION, SHOWING DRY SPACES

The soil first received an irrigation of six inches in depth over the surface, and in the tanks which had no mulch over one-third of this amount was evaporated in thirty-two days, while less than one per cent was evaporated in the tanks which were protected by a nine-inch mulch.

Similar experiments carried on at Wenatchee, Washington, in June, 1908, showed the following losses in twenty-one days: No mulch, fourteen and one-third per cent of water applied; three-inch mulch, four per cent; six-inch mulch, two per cent, and nine-inch mulch one per cent.

From the foregoing it is evident that Western orchardists can prevent the greater part of the evaporation losses by cultivating orchards to a depth of at least six inches as soon as practicable after each irrigation.

In the preceding paragraphs attention has been called to the large amount of water which is vaporized from warm, moist soils. We wish here to call attention to another loss of a different character. In all modes of wetting the soil, but more particularly when deep furrows are used to distribute the water, a part is liable to sink beyond the deepest roots. As a rule the longer the furrow the greater is the loss from this cause. In furrows about one-eighth of a mile long Dr. Loughridge, in his experiments at Riverside, California, found that in some parts of the orchard the soil was wet as a result of a recent irrigation to depths of twenty to twenty-six feet, while in other parts the moisture had not penetrated beyond the third foot.

One of the best ways of finding out whether much water is lost by deep percolation is to dig cross trenches as deep as the feeding roots go. The moisture which passes the deepest roots in its downward course may be considered as wasted.

An example of fairly even and desirable moisture distribution from furrows is shown in sections XI and XII of Figure 28, where the three curved lines show the margins of wetted moisture at the end of one, two and three days, respectively.

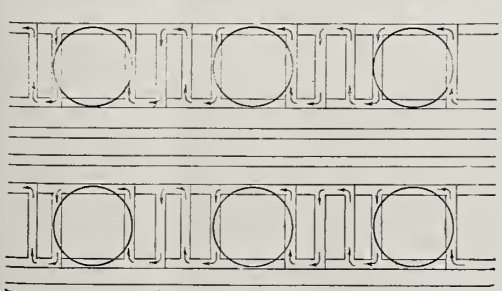


FIGURE 20—CROSS FURROWING DRY SPACES

The loss of water is not the only effect of deep percolation. The water which escapes in this and other ways usually moves through the soil at a rather slow rate of speed until it reaches some underground body of water at a lower level. In case orchards have been planted at these lower levels when the sub-soil was dry care should be exercised in observing the rise of the ground water level. The small post-hole auger shown in Figure 29 is one of the most convenient tools to use in making test wells to keep track of the behavior of the ground water. Before the deepest roots of the fruit trees are submerged artificial drainage ought to be provided. Otherwise the ground water will at first lessen the yield, and finally destroy the trees.

The drainage of orchard tracts usually progresses in more or less distinct and separate stages. When the ground water begins to be a menace the natural ravines in the vicinity are cleared of weeds and other rubbish, and deepened. If the ground water continues to rise the open drains are deepened and extended, or else the excess water is withdrawn through a covered drain.

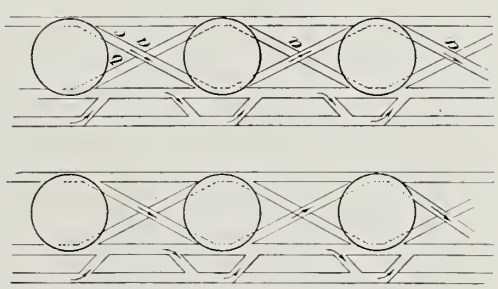


FIGURE 21—USE OF ZIG-ZAG FURROWS

Open drains in orchards occupy valuable land, obstruct field work and are expensive to maintain. Some of these objections can be lessened, if not entirely removed, by locating such drains along the lower boundary of the tract. When this plan is followed covered drains are frequently laid among the trees, and discharge into the open drains. Sometimes the source and direction of the waste water which is waterlogging an orchard can be traced beneath the surface. In this event it is well to try to intercept its passage before it reaches the trees. This can be done by an open drain, but a covered pipe drain of the required size is preferable. Where durable lumber is cheap box drains similar to that shown in Figure 30 may be used. Where lumber is high in price it will be more economical to use pipe drains made of either clay or cement. The former is most frequently used for sizes ranging from four to eight inches in diameter and the latter for sizes ten inches and over. The clay or tile drains are made one foot in length, but in using cement for the larger sizes the length may be increased to two, and even three feet.

The drainage of irrigated lands differs in many respects from that common to the humid States of Iowa, Illinois or Ohio. In irrigated districts the drains are larger and are laid deeper. While four-inch tile drains may be used in places six-inch drains are to be preferred, and should be considered as the smallest desirable size. The depth at which they are laid ranges from four to seven feet, and five to six feet are required for orchards. A grade of five feet to the mile is about the least that should be used, and wherever practicable it should be increased to ten feet to the mile.

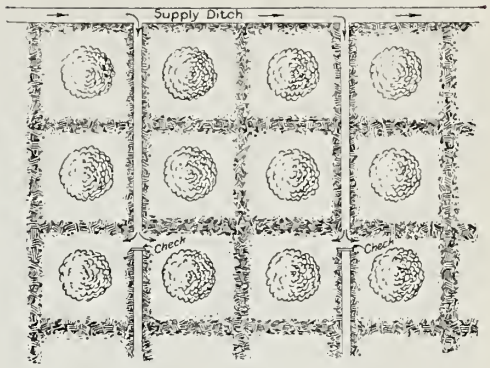


FIGURE 22—BASIN METHOD OF IRRIGATION

In laying drains that are likely to become clogged with silt or roots, or both, a small cable is laid in each line, and at distances of 300 to 500 feet sand boxes similar to Figure 31 are placed, so as to facilitate cleaning the tiles with suitable wire brushes.

The large majority of California fruit growers do not grow marketable crops between the trees. They believe in clean culture, except where leguminous crops are used to renovate and fertilize the soil. From the standpoint of the large commercial orchard and the well-to-do proprietor this practice has much to recommend it. The planting of such an orchard is regarded as a long-time investment. Little, if any, returns are expected for the first few years, but when the trees approach maturity and are in full bearing the anticipated profits are supposed to compensate the owner for all the lean years. Any treatment, therefore, which tends to rob the soil of its plant food when the trees are young or to retard their growth is pretty certain to lessen the yields and the consequent profits in later years. Professor E. J. Wickson, director of the California Experiment Station, tersely expressed the prevailing opinion on this question in California in his work, "California Fruits, and How to Grow Them," in the following language: "All intercultures

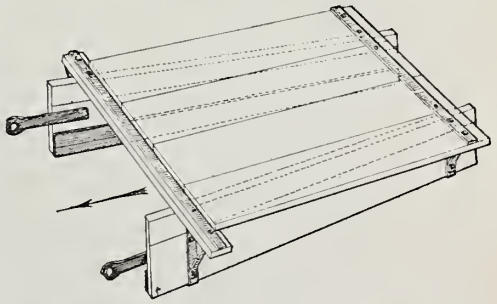


FIGURE 23—RIDGER USED IN BASIN IRRIGATION

are a loan made by the trees to the orchardist. The term may be long and the rate of interest low, but sooner or later the trees will need restoration to the soil of the plant food removed by inter-cropping."

Mr. S. W. McCulloch, who controls 150 acres of citrus orchards in Southern California, goes further in stating: "It is always detrimental to the development of an orchard to grow crops between the trees. In some cases the effect is not marked aside from securing less rapid growth, but it will affect the crops of fruit for several years, and in the end nothing will be gained."

Notwithstanding all this the poor man must needs make the loan or his children may starve. The settler on a small tract set out to young trees cannot afford, if his means are limited, to wait four or five years for the first returns. He must produce crops between the rows, and the question for him to consider is how this can be done with the least possible injury to the trees. A plentiful supply of water and a deep, rich soil are the essentials of inter-cropping. In districts that depend on a meager rainfall of fifteen to twenty inches per annum, or where irrigation water is both scarce and costly, the practice becomes of doubtful value under any circumstances. In most of the fruit districts of the West water for irrigation is still reasonably low in price, and the extra amount required for inter-cropping represents but a small part of the net gains from such crops.

Shallow-rooted plants are considered the most desirable for this purpose. Squash, melons, sweet potatoes, tomatoes and peanuts are the most common in California. The cultivation is done with one horse and a small cultivator. A clear space three to four feet wide is left on each side of the young trees. In the Verde River Valley of Arizona strawberries, lettuce, onions and melons are raised in the young orchards. In parts of Idaho alfalfa fields are frequently plowed under to plant trees. When this is done berries, beans, melons, onions and tomatoes can be grown between rows for several years without any apparent injury to young trees. In Northern Colorado raspberries, gooseberries, currants, as well as corn, beans and peas are often planted in orchards, while in Southwestern Kansas it is usually cabbage, melons and sweet potatoes.

In the young apple orchards of Hood River Valley, Oregon, strawberries are frequently planted between the rows. The manner in which this is done, as well as the system of contour planting which is there practiced, is shown in Figure 32. The manager of a large apple orchard company in Montana states that no appreciable effect is noticed on apple trees as a result of growing potatoes, cabbage, beans, onions and other vegetables between the trees, providing the inter-crops are well cultivated and irrigated. In the fruit districts of Washington inter-cropping is a common practice. In 1907 a fruit grower raised on ten acres of two-year-old trees cantaloupes, tomatoes, peppers, cucumbers, corn, radishes, beans, peas, potatoes and turnips, all of which netted him $2,086.50, or an average of $208.65 an acre.

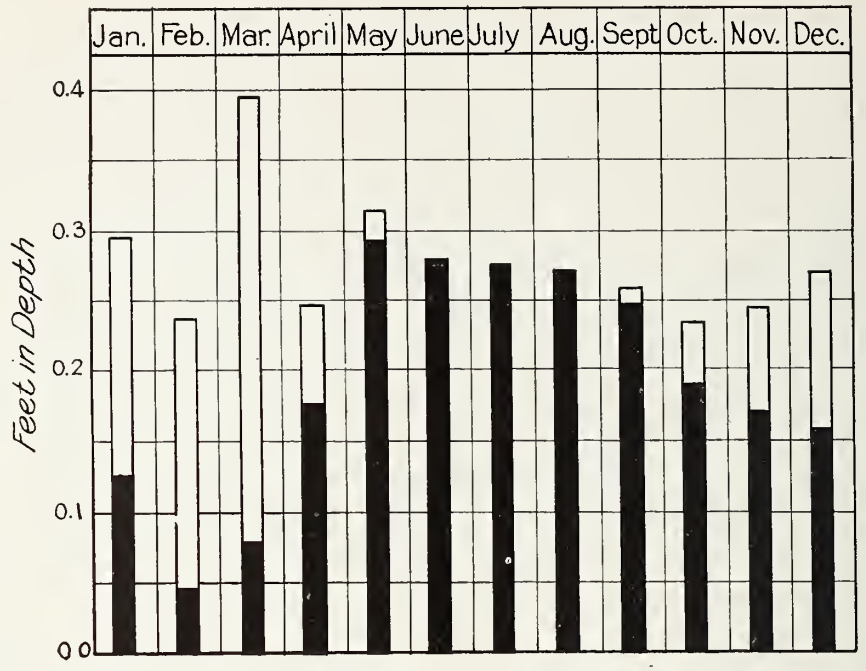


FIGURE 25—AVERAGE DUTY PER MONTH UNDER RIVERSIDE WATER COMPANY DECEMBER 1, 1901, TO NOVEMBER 30, 1908

While opinions differ regarding the wisdom of growing such crops as have been named between the tree rows, most fruit growers are convinced of the beneficial effects of cover crops. Notwithstanding the scarcity and high value of water in the Riverside citrus district the superintendent of a large fruit company has for years grown peas and vetch in the orange and lemon orchards under his management, and advocates the free use of irrigation water to supplement the winter rains for the rapid and vigorous growth of such crops. In the walnut groves of Orange County, California, bur clover is sown in the fall, given one or two irrigations during the winter if the rainfall is below the normal and plowed under in April.

The cost of such cover crops as peas, vetch or clover includes the seed, the labor of sowing it, the water and the time required to apply it. These items, according to Dr. S. S. Twombly, of Fullerton, California, amount to from $2.50 to $3.25 per acre. Twenty tons per acre of green material is perhaps an average crop. In this tonnage there would be about 160 pounds of nitrogen, which, at twenty cents per pound, represents a value of $32 per acre for a cover crop like vetch.

When water is used outside of the regular irrigation period or, what is in many cases equivalent, outside of the growing season it is termed winter irrigation. Over a large part of the arid region the growing season is limited by low temperatures to 150 days or less, and when the flow of streams is utilized only during this period much valuable water runs to waste.

It was for the purpose of utilizing some of this waste that the orchardists of the Pacific Coast states and Arizona began the practice of winter irrigation. The precipitation usually occurs in winter in the form of rain, and large quantities of creek water are then available. This water is spread over the orchards in January, February and March, when deciduous trees are dormant. The most favorable conditions for this practice are a mild winter climate, a deep, retentive soil which will hold the greater part of the water applied, deep-rooted trees and a soil moist from frequent rains.

The creek water which was applied to some of the prune orchards of the Santa Clara Valley, California, during the winter of 1904 was measured by the agents of this office with the following results: From February 27 to April 23, 1,241 acres were irrigated under the Statler ditch to an average depth of 1.58 feet. From February 12 to April 23, 2,021 acres were irrigated under the Sorosis and Calkins ditches to an average depth of 1.75 feet. In the majority of cases the orchards which are irrigated in winter in this valley receive no additional supply of moisture other than the rainfall of about sixteen inches.

In the colder parts of the arid region winter irrigation is likewise being practiced with satisfactory results. The purpose is not only to store water in the soil, but to prevent the winter-killing of trees. Experience has shown that it is not best to apply much water to orchards during the latter part of the growing season, since it tends to produce immature growth which is easily damaged by frost. In many of the orchards of Montana no water is applied in summer irrigation after August 20. Owing, however, to the prevalence of warm chinook winds, which not only melt the snow in a night, but rob the exposed soil of much of its moisture, one or two irrigations are frequently necessary in mid-winter.

SECLECTING AND THE IRRIGATION OF ORCHARDS

BY DON H. BARK, IRRIGATION ENGINEER IN CHARGE OF INVESTIGATIONS OF IDAHO

LARGER profits are no doubt made from orchards under favorable conditions than from any other crop grown in Idaho. This is true, however, only when the orchardist understands his business and when all conditions are right. Under adverse conditions the losses from orcharding may be equally as great as the gain under favorable conditions. Orchards require a larger outlay than almost any other crop at the start owing to the fact that the trees are expensive and that no returns can be had before the fifth year. This emphasizes the fact that great care should be taken at the outset in the selection of varieties and the site on which to plant the trees, as well as in the preparation of the land and the care of the trees after planting.

The selection of a favorable site at the outset is very essential, for even the best of trees and care will not bring large profits on a poor site. In localities susceptible to late spring frosts a high, sloping field should be selected. The most favored sites in this section are generally those which slope toward the north and northeast. These slopes do not receive the direct rays of the sun in the hot part of the day, and the trees will be held back to a considerable extent in the spring and the blossoms are not liable to appear until after all danger from frost is passed. Orchards do best on deep, well drained soil. Trees are gross feeders, and the soil should be loose enough so that the roots can readily penetrate to considerable depth. Almost any of our Idaho soils that fulfill the above requirements should grow good trees. Where one insists on planting an orchard on soil that is underlaid at a shallow depth, with hardpan, it has been found to be beneficial to break the hardpan under each tree, either by mechanical means or by the use of some explosive. This loosens up the soil so that the roots and water can get down through the hardpan. The action of roots and water will soon soften and disintegrate all but the most persistent of hardpan. Our raw soils as a rule contain but little humus, and for that reason orchards will do much better if planted upon ground that has been in clover or alfalfa for two or three years. Many do not care to wait until the clover has added the necessary humus and insist upon planting orchards on raw soils. In such cases the ground should be leveled before the trees are planted and red clover should be planted as a cover crop during the first or second year. This supplies the necessary humus and nitrogen at a very rapid rate, and in many cases orchards do as well as when planted on soil that has grown clover for some time. Alfalfa should never be planted in an orchard, as it is a deep rooted, gross feeder and is too hard to kill out.

After one has selected the site for an orchard and has decided whether he will plant it on new or old ground the next thing to think about is the laying out of the ground and the preparation of the land. Should the orchard be planted on raw ground about the first thing that should be thought of is the supply ditch for the land. This, of course, should be built of sufficient size and capacity, and should be made to run along the highest side of the field. The proper grade for supply ditches on ordinary soils is about two inches to the hundred feet.

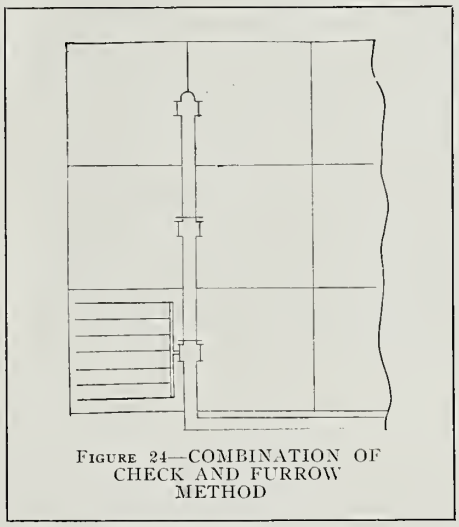


FIGURE 24—COMBINATION OF CHECK AND FURROW METHOD

Several kinds of systems are used for the irrigation of orchards, but the furrow system is by far the most common in this locality, and is to be recommended in most cases. Where the furrow system is used the tree rows should be laid out at the beginning according to the topography of the land and in such directions that the water can be made to run down along and parallel to the tree rows. Many who are new at the business do not consider that the ground needs much leveling and preparation before putting in orchards, as they are inclined to think that the water may be guided in almost any direction by means of deep furrows along the tree rows. This, however, is a mistake. The land should be thoroughly leveled, so that the ground can be irrigated evenly over its entire area. This is found to be essential when cover crops are planted in the orchard. If the ground is uneven and poorly prepared an even stand of the cover crop, which is so essential, cannot be secured. With ground that is quite uniform and has only small irregularities of surface the common float, or plank leveler, is sometimes all that is required for leveling. This should be run across at least once in each direction in order to secure an even surface. If knolls and irregularities exist that cannot be taken off and evened up by this method the Fresno scraper will be found an efficient tool. In leveling the ground for irrigation it must be borne in mind that the hollows which are filled with loose dirt will settle, and must be filled full enough to make an allowance for the settlement after the water is applied.

The Shuart grader is a tool which is coming much into use for the preparation of new land. Although it will not move as much earth in a day as the common Fresno better work can be done with it in the hands of a novice.

It has been my experience that it is always best to run the furrows and tree rows down the greatest slope unless it is excessive, in which case they must be circled around the side hill at a slight grade more nearly approaching a contour. It is natural for water to run down the steepest slope, and it will need much less attention than if run in some other direction. Washing is prevented by using some device to regulate the flow of water in each furrow. Lath tubes in the ditch banks are frequently used for this purpose. Steep slopes must be irrigated with comparatively small amounts of water in each furrow in order to prevent washing. Many orchards have been planted in the last few years upon steep side hills, many of which are far too steep to allow the water to be run down the slopes. In

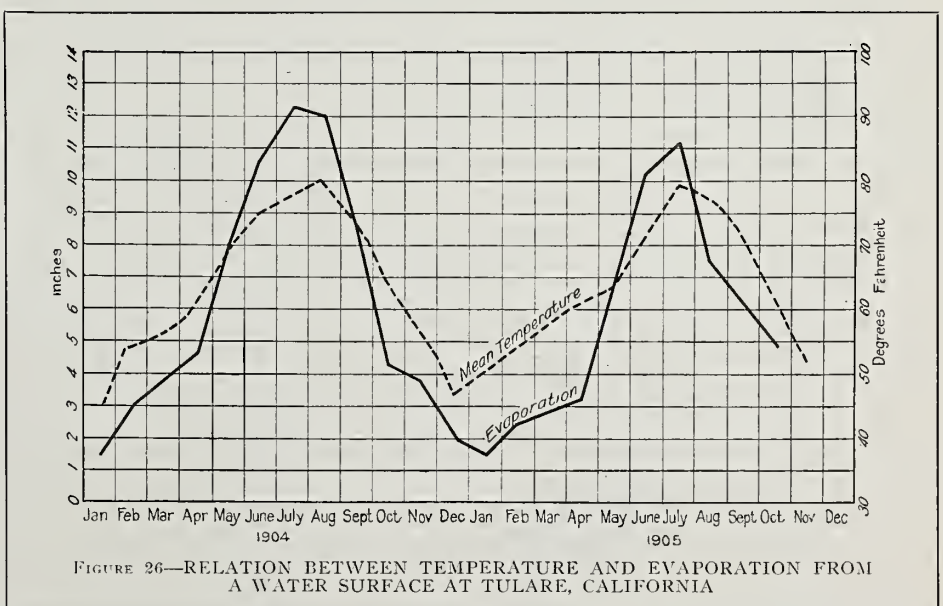


FIGURE 26—RELATION BETWEEN TEMPERATURE AND EVAPORATION FROM A WATER SURFACE AT TULARE, CALIFORNIA

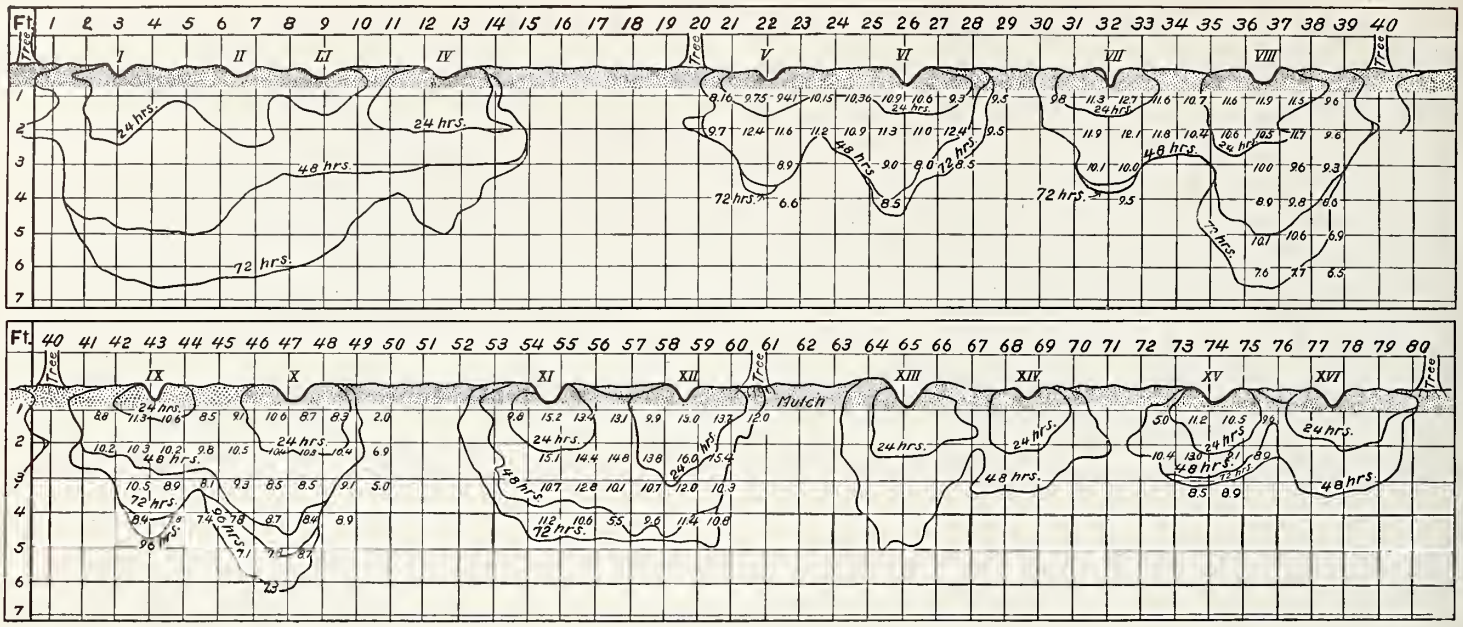


FIGURE 28—OUTLINES OF PERCOLATION UNDER SIXTEEN FURROWS IN ORCHARD 58, UNDER GAGE CANAL, RIVERSIDE, CALIFORNIA

this case the head ditch should be brought straight down the side hill, the water being carried in a wooden or concrete flume. The furrows along the tree rows are then made to diverge each way from this flume around the hill, with but a slight fall. The water is checked up opposite the end of each tree row by short pieces of lath, resting against cleats on the sides of the flume, and the amount for each furrow is regulated by tin or wooden slides on the outside of the flume. Perhaps the best and most efficient system of orchard irrigation is the one which is now in operation at Lewiston. This is a pressure system, the water being carried in pipes which are laid under ground similar to an ordinary water works system, a hydrant being placed at the upper end of each tree row. This system is very saving of water and has been in successful operation at Lewiston for the past several years. The water for a good share of our city lots in this town is also carried from the ditch in underground pipes in much the same manner.

An irrigation ditch is the best insurance that one can have against loss of trees in transplanting. If prime, hardy stock, in good condition, can be secured there is small necessity of losing over two per cent of the trees after they are set out. Trees with plenty of root should be secured, and then care should be used that the roots never be left to dry out from the time the tree leaves the nursery until it is set in the orchard. The hole should be dug before the trees are unpacked or taken from the trench where they have been "heeled in." After this is done the trees may be hauled to the orchard, the roots being kept covered by a wet blanket or straw while en route. The holes should be plenty large, say about eighteen inches square and eighteen inches deep, for one year old trees. After the roots are pruned the tree should be held upright in the hole some six inches deeper than in its former position in the nursery while the hole is filled half full of top soil. Water from the nearby irrigation furrows should then be let in until the hole is nearly full of water, after which the tree should be worked up and down slightly until the roots are thoroughly "puddled in" and the soil has come into intimate contact with all the roots. The hole should then be filled up with dry soil, leaving the tree planted three or four inches deeper than in the nursery. If this method is carried out the soil will be settled firmly around all of the roots, the same as an old tree, and growth will start just as soon as the weather warms up.

A large per cent of all losses in transplanting is caused by the roots being allowed to dry out in transit or by setting the trees haphazardly in dry soil. One is always well repaid for the care he takes in planting his trees.

During the first season an irrigation furrow along one side of each tree row will probably be sufficient, but during the second year a furrow should be run along each side of the tree rows. As the roots spread during the succeeding years more and more of the area between the rows must be irrigated. Cultivation, of course, must go hand in hand with irrigation, for much moisture can be saved by maintaining a dust mulch on the surface. My department has shown by repeated experiments that there is four times as much evaporation from an uncultivated field in a single month as from one covered with a dry three-inch soil mulch. Deeper mulches are also more effective in retaining moisture, for it was shown that there is sixteen times as much evaporation from an uncultivated soil as from one covered with a nine-inch dry soil mulch. This strikingly shows the effectiveness of cultivation in retaining moisture. This is not the only advantage, however, as cultivation stirs up and areates the soil as well, which is also highly desirable and beneficial.

Years of observation and experiment have demonstrated the fact that soils must not be saturated at any time if good results are to be secured. Plants and trees require that there be some air in the soil, and seem to do best when about half of the pore space of the soil is filled with air and the other half with water. Thus we see the harmful effects that may result from over-irrigation, which fills all of these pore spaces and drives out the air which is so essential.

Different soils and seasons will require a different number of irrigations during a season, and for this reason no hard and fast rule can be laid down as to the number of irrigations to apply during the season. An experienced irrigator seems to know by intuition when his crops need irrigation, but this cannot always be depended upon by the beginner. A good way to tell when trees

FIGURE 27—TANK EXPERIMENTS AT RENO, NEVADA, TO DETERMINE EFFECT OF SOIL MULCHES IN CHECKING EVAPORATION

need irrigating is to dig down into the soil near the roots and examine the soil. If the soil retains its shape when squeezed in the hand there is probably sufficient moisture, but if it has a tendency to fall apart the trees should be irrigated at once. Much experimentation must yet be done before we are able to tell as to what times during the season the trees need the most water. Our experiment station should now be working along this line.

A few general truths are self-evident, however, and have already been demonstrated. There is a period in the growth

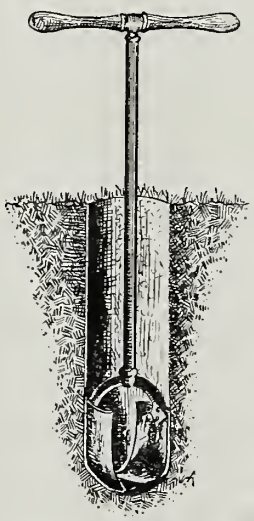


FIGURE 29—SOIL AUGER
Used to locate ground-water level.

when the fruit increases rapidly in size. With apples this is usually in June and July, during which time the trees must not be allowed to want for water.

Young trees grow very rapidly in this locality, and cases are common in which the tender shoots have been killed and the trees ruined by early fall frosts. Water should not be applied to young trees in this locality after August 20th or September 1st, but should be withheld in order that the rapid growth may stop and the wood toughen up before the early freezes.

Many inquiries have been received during the past year in regard to the

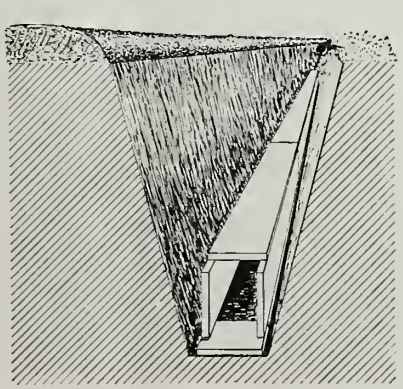


FIGURE 30—BOX DRAIN

FIGURE 32—ORCHARD SHOWING STRAWBERRIES BETWEEN ROWS OF TREES

water requirements of orchards. This has never been fixed within very narrow limits. It unquestionably varies with the class of soil and sub-soil, and with the climate, as well as with the skill of the irrigator.

I have been carrying on the largest duty of water investigation during the past year that was ever attempted. In co-operation with the state engineer I have measured the yields produced and the water used upon over 120 different fields in different parts of the state, and some very interesting results have been secured. Unfortunately no orchards were included in the investigation, but we are able to reason back very closely from what was required by other crops, such as potatoes, etc., and I am of the opinion that from one to one and a half feet in depth during the season will be found sufficient for orchards on ordinary Boise Valley soils. This amount would be supplied during a season with but a trifle less than one-half a miner's inch per acre. The investigation will be carried on again during the coming year, and it is hoped to include orchards in the investigation.

In summing up the many factors which the orchardist must take into consideration I wish to emphasize the following:

1. A good site which is free from frost must be selected, and it is highly desirable that the orchard be planted on deep, well drained soil.

2. The ground should be well leveled and laid out for irrigation. The strips between the trees should also be prepared so that water can be economically applied.

3. Good stock should be selected, and the roots should never be allowed to dry out from the time the tree is dug until it is planted again. A good sized hole should be dug and the roots should be thoroughly "puddled in" with water when the tree is planted.

4. The soil of orchards should never be saturated with water. Plant growth demands that there be some air in the soil. There is most need for water in June and July and the first part of August.

5. A deep dust mulch, such as is produced by thorough cultivation, is beneficial in conserving moisture.

6. Young trees should never be irrigated too late in the fall.

7. The condition of the soil should be closely watched in order to determine when to irrigate. On ordinary soils orchards require from one to one and a half feet in depth during the season.

In conclusion let me say that the good sense of the tiller of the soil must be brought to bear in the application of water to his land. Study the surrounding conditions, and let those conditions be your guide—do this and success will come, in face of the many failures of those lacking in observation.

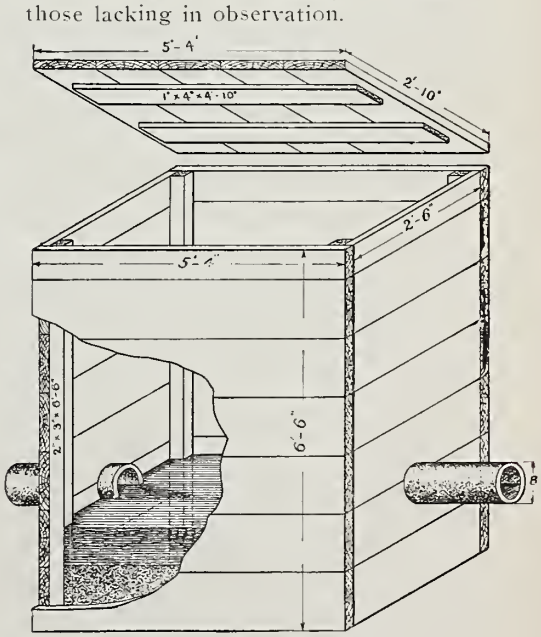


FIGURE 31—SAND BOX IN TILE LINE

BEST METHODS OF APPLYING WATER TO CROPS

BY SAMUEL FORTIER, CHIEF OF IRRIGATION INVESTIGATIONS, EXPERIMENTAL STATIONS, U. S. DEPARTMENT OF AGRICULTURE

SIXTY years ago the practice of irrigation was new to the people of this country. In the gradual development since then many methods and devices have been tried, but comparatively few have been successful. Costly experiments in irrigation have been made, but in only a few cases have the results justified the expense.

Out of these trials and failures there have been evolved, however, certain well established ways of doing things, which under given conditions are considered superior to any other methods yet devised. The purpose of the writer in preparing this article is to present some of the features of irrigation practice which have successfully stood the test of repeated trials under widely different conditions. It is not claimed that the methods herein described represent the highest achievement of Western people in this direction. They but mark a step in a rapid development in which that which is considered best this year may be superseded by something better next year.

The agricultural wealth of that vast region lying west of the Missouri River was first made known by men who were poor in worldly goods but rich in those physical and mental endowments which go to make up the best type of citizenship. Their poverty, unfortunately, compelled them to make use of the cheapest methods in rendering the arid lands productive. Water was led from the nearest stream in a plow furrow, and the irrigator, in wet feet, tried to spread it over the field by the use of a shovel. The small and cheap equipment, consisting of a walking plow and shovel, has given place to a large number of implements, and the simple, laborious manner of applying water has been broadened out into more than a half dozen standard methods, yet in studying the latest improvements it is evident that many of them are mere makeshifts and that much remains to be done before the water of Western streams is efficiently and economically applied to arid lands. To aid in remedying this defect the irrigation investigations of the Department of Agriculture were instituted nearly a dozen years ago, to be carried on wherever practicable in conjunction with the Western experiment stations. One of the results of these investigations has been to show that a large part of the water annually diverted from natural streams is wasted by reason of the crude and defective means employed in its transporation, delivery and use. While it is true that the waste in irrigation waters is diminishing, land now being irrigated in many parts of the West with one-third of the water formerly applied, yet there is still much to be done before the highest duty is reached.

The far-reaching importance of better methods of using water is readily seen when one considers that the extent of land now irrigated, based on the estimates of Western state engineers and others, is approximately 13,000,000 acres. According to the results of measurements made by the office of experiment stations the quantity of water which is diverted annually from streams and other sources of supply to water this extent of land approximates over 50,000,000 acre feet. It is believed that only about one-third of this volume of water is utilized in nourishing plant growth, the balance being wasted. As the writer has frequently pointed out, all of this waste of water cannot be prevented, but it is thought that enough might be saved to irrigate, under careful use, about 7,000,000 acres.

An irrigated farm resembles a city in that it should be skillfully laid out before many permanent improvements are made. In such preparatory work perhaps the most important feature consists of the location and construction of the network of ditches required to carry and distribute water to all parts of the farm and the head gates, turn-outs, pipes, flumes and road crossings which these ditches make necessary. Farm ditches are of two kinds, temporary and permanent. The former is intended to last through but one season, or for but one crop, and its location is not important. The latter should be as definitely fixed as any other permanent improvement on the farm. The location of all permanent ditches should precede the division of the farm into fields, the building of fences and the laying out of farm roads and lanes. The chief reason for this course is that there may be but one direction in which water will flow at the proper rate of speed. Too often the mistake is made of building ditches for only a part of the farm. This is pretty certain to cause, it may be years later, a complete change in most of the existing improvements or else a faulty arrangement of most of the essentials of an irrigated farm.

The head gate at the upper end of the supply ditch marks the point where the control of the canal company ceases and that of the water user begins. Sometimes the water is measured out to the user. A concrete hydrant having a weir and portions of two distributing flumes are shown in Figure 1.

Formerly all water channels pertaining to the irrigated farm were formed in porous earth, which wasted a large part of the water through seepage. Wooden flumes were substituted later for part of the channels in earth, and pipes, concrete lined ditches and concrete flumes are now gradually taking the place of both earth and wood. The larger of the farm ditches in earth are made by first plowing a few furrows and afterwards removing the loose dirt by means of a wooden implement formed like the letter A. The smaller ditches can best be made by a lister plow attached to a sulky frame, Figure 7.

The location and construction of the principal water channels for the farm is followed by the preparation of the surface of the fields for irrigation. Four more or less distinct kinds of land under ditch are undergoing this change. There is the land which has been devoted to grain growing under the natural rainfall. The second class consists of low land covered by native grasses, cacti or low bushes. The third comprises the heavy sagebrush land of the Mountain States, while the fourth contains more or less shrubbery and small trees interspersed among smaller desert plants. In the first two kinds deep plowing is all that is necessary before beginning the work of grading and leveling, but when heavy desert growths are encountered special contrivances must be used. A covering of sagebrush is most easily removed by dragging a rail or heavy timber over the field, Figure 3. The stumps which remain are either grubbed out by hand or are plowed out. The mesquite of the Southwest and pine and juniper trees of the Northwest are grubbed out by hand

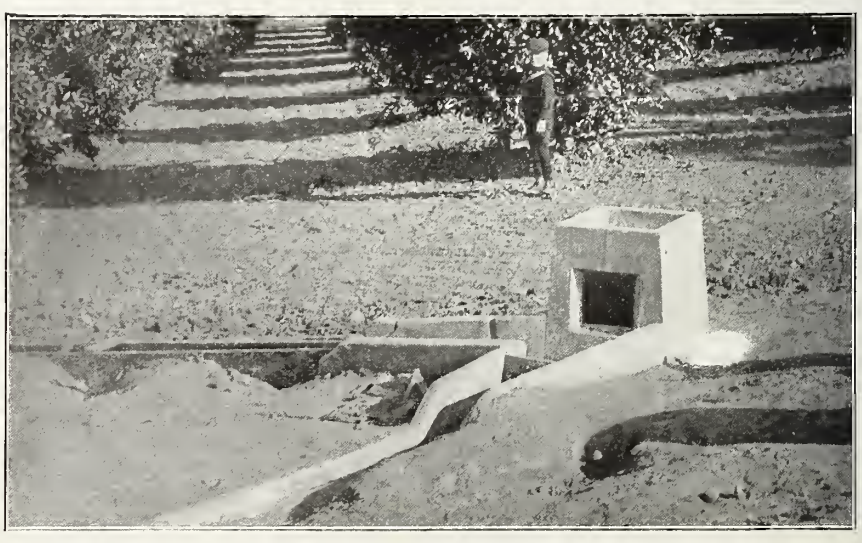


FIGURE 1—CONCRETE HYDRANT FOR MEASURING AND DISTRIBUTING WATER ARLINGTON HEIGHTS, RIVERSIDE, CALIFORNIA

or are removed by stump pullers, dynamite or fire.

Flooding the surface of land from field ditches or laterals is the most common means of wetting soil. This method is general in the Rocky Mountain States, and the conditions which prevail there seem to be well adapted to this mode of applying water. It can be used on quite steep slopes and in various other ways fits in with the requirements of the irrigator on the more elevated lands. It consists in leveling, grading and smoothing the surface of fields to such a degree that water will readily flow over it. As a means of distributing the water over the field small ditches or laterals are located along the best routes. These form a network of channels which cut up the field into small strips, which are usually from fifty to one hundred or more feet in width. Custom differs as to the direction of these field ditches. Sometimes they extend down the steepest slope of the field regardless of the fall, at other times they follow grade lines and extend from the head ditch in more or less curved lines across the field, Figure 8.

In preparing a field for this method it is first plowed and harrowed and then graded. Several good home-made implements are used to reduce the surface to an even, uniform grade. A convenient implement to make field laterals is shown in Figure 7. It consists of a lister plow, either fourteen or sixteen-inch, attached to a sulky frame and drawn by three horses. When the ditches extend down the steepest slope of the field they are located by eye, but when they are located on grade lines, as in Figure 8, some kind of a surveying instrument is frequently required to establish the grades. A suitable fall for these small channels is one-half to three-fourths inch to the rod.

The check method is illustrated in a general way in Figure 9. It consists in the division of the field into checks, or compartments, each having a comparatively level floor space surrounded by a low, flat levee and a bordering supply ditch.

The checks are made in one of two more or less distinct ways. These are known as the "rectangular," Figure 9, and the "contour." The boundaries of the former are straight, forming rectangles which are usually much longer in the direction of the least slope, while the boundaries of the latter conform to the natural slope of the land.

The field should first be carefully surveyed and the margins of the checks marked by a plow furrow or in some other way. The levees are formed by scrapers, which remove the earth from the high parts of the floor and deposit it on the levees. Leveling devices of various kinds are subsequently used to grade the floor and trim the low embankments. An essential feature in checking land is to arrange each tier of checks in such a way that each can be flooded from a supply ditch. Wooden gates in the ditch banks admit the required amount of water.

In all essential features the basin method does not differ from that just described. The fact that basins are used in the irrigation of orchards and checks in the irrigation of alfalfa, and the further fact that basins are much smaller and last but for one season, have served to distinguish between them and to accord to each a separate place.

FIGURE 2—PUMPING PLANT FOR RICE IRRIGATION

Orchards are prepared for irrigation by this method by forming ridges of the loose earth midway between the rows of trees in both directions in the manner shown in Figure 10. These ridges are made with ordinary walking plows by throwing up two furrows or else by a ridger. When the top soil is light and free from weeds only the ridger is required, but in more compact soils and on soils covered with weeds the surface should first be disked. This method is well adapted to the warmer portions of California, Texas, Arizona and New Mexico, where the winter irrigation of orchards is becoming a fixed practice. Water is then abundant and large quantities can be applied when the land is thus formed into small compartments.

One of the most common ways of fitting the surface to be flooded is to divide each field into narrow strips or "lands" by means of low, flat ridges of earth. These ridges extend from the head ditch at the upper margin of the field down the steepest slope to the bottom. When the slope is too steep they follow a diagonal course. In either case the field is divided into bands or borders, each of which is watered separately. Figure 11 shows a portion of the head ditch having three gates, through which water is flowing into as many borders. The tract is first plowed or disked and then laid out in narrow parallel strips by plow furrows, which mark the locations of the levees. On an average the levees are spaced about fifty feet apart and extend a distance of 800 or more feet. They are usually formed with a scraper, which is driven back and forth in a direction at right angles to that of the markings, and as each full scraper crosses a marking it is dumped and the surface is again skimmed over to collect earth for the next levee. The ridges or levees thus formed are too steep and irregular and they are trimmed and flattened by suitable implements until their height is not more than eight to ten inches and the base is six to seven feet wide. The land between the levees is carefully leveled and graded so as to permit water to flow in a thin sheet from the top to the bottom of each border.

With the exception of flooding from field laterals, the furrow method is more generally employed than any other. In its main features it is extremely simple. There is only the making of a furrow in cultivated soil for the passage and absorption of a small stream of water. From so simple a beginning many modifications have been evolved, most of which pertain to devices employed to distribute water among the furrows.

The common practice among unskillful irrigators on poorly prepared fields results in an uneven wetting of the soil, waste of water and reduced yields. Before watering orchards or such crops as sugar beets, potatoes and corn furrows are made between the rows with a light plow or cultivator. Water is then admitted into the head ditch at the top of the rows, its surface is raised by checks to the required height and the furrows are supplied with water by making openings in the head ditch. The chief objection to this crude and inexpensive plan is the unequal distribution of water to the furrows.

A more even division of water among furrows can be made by using short tubes in the lower bank of the head ditch. These tubes are most frequently made of laths or slightly larger strips of boards, but may be made of cement, iron or tin. By means of check gates, spaced near or far apart according as the grade is steep or flat, the surface of water is kept up to the proper height, and the tubes are so placed that their upper surfaces will be on the same level and some little distance under water. Figure 12 shows the distribution of water from such boxes. In the Northwest, where lumber is cheap, wooden flumes with small openings on one side are

rapidly taking the place of earthen head ditches. These flumes vary in width from eight to twelve inches, and the openings are controlled by metal or wooden gates in the manner shown in Figure 13. Throughout the southern and central portions of California cement flumes and pipes of various kinds are quite generally used to distribute water to furrows. A common type of flume is shown in Figure 14. In the process of building, and before the cement hardens, small metal tubes are inserted on the side next to the orchard, the flow through each tube being regulated by a gate of the same material. When pipes are used a line is laid across the top of the tract to be watered at the proper depth below the surface, and at regular distances standpipes are inserted to bring the water to the surface, where it is divided between a number of furrows by special devices.

Where water is pumped from wells, and where it is conducted from gravity canals under pressure, a convenient way of irrigating certain crops is by means of surface pipes. These pipes are made at the factory into convenient lengths, usually ten feet, of various diameters, and of different weights and kinds of metal. When not in use they are stored in an outbuilding or shed and carted to the field which is in need of water. In the main feed pipe, which is laid underground across the top of the field to be watered, there are standpipes at regular intervals, and a length of the movable pipe is attached to the lowest standpipe, using heavy canvas hose to make the connection. To this length others are attached until a line extends on one side of the field to within a short distance of the bottom. When the water is turned on a section of canvas hose serves to distribute the water down the slope and as far on each side as the hose will reach. Several lengths of pipe are then removed and carried over to an adjoining strip. The hose is again attached and another block of land watered. In this manner an entire strip on one side of the field is watered, and the pipe is again strung out in such a way that the strip next to the first can be watered.

In 1909 the farmers of Louisiana, Texas and Arkansas received more than $18,000,000 for their irrigated rice crop. The well drained, rich soil of that warm, humid region, when abundantly supplied with water at the proper time, is well adapted to the needs of this crop. Unlike most crops, rice must not only be

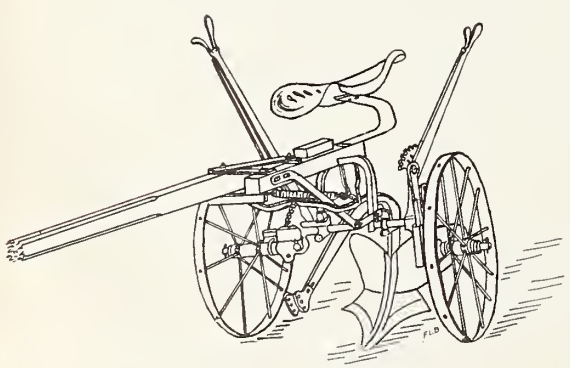


Figure 7—LATERAL DITCH PLOW

Figure 3—CLEARING BRUSH IN IMPERIAL VALLEY, CALIFORNIA

flooded, but the top soil must be kept either continuously moist or submerged for a considerable part of the time. In the river sections of Louisiana two systems of culture—the wet and the dry—are employed. In the wet method the fields are flooded and plowed in the water to a depth of two and one-half to four inches in April or early in May. The seed is sown broadcast and harrowed in, after which the water is turned off, and the rice speedily germinates. In the dry method the land is plowed, harrowed and seeded from the middle of March to the first of July in a manner similar to the treatment given other cereals. Under both methods a little water is turned on when the rice is four to six inches high. If the water is cold it must be used sparingly on early rice, while on late rice a sufficient depth of water must be maintained to prevent scalding. Unless the crop is attacked by insects the water, after being turned on, is kept on continuously until withdrawn previous to the harvest.

In the prairie districts of Louisiana, Texas and Arkansas, where over eighty-five per cent of the total yield of this country is grown, the fields are plowed two to three inches deep at any convenient time between the harvesting of one crop and the planting of the next. Unless the soil is very hard no irrigation is needed before seeding. The most common varieties are Honduras and Japan rice, the acreage in the former being about double that of the latter. Japan rice grows more slowly, requiring about fifteen days more time to mature. Advantage is taken of this to increase the length of the growing, as well as that of the irrigating season, in order that the largest possible acreage may be handled by a given number of laborers. The time of seeding extends from the middle of March to July. The Honduras rice is planted first, and there is usually sufficient rainfall to germinate the seed. In case irrigation water is needed to sprout the seed it should not be allowed to remain more than a few hours or it will cause the seed to rot. Water, as a rule, is not needed on the Japan rice, or again on the Honduras rice, until the plants are from four to six inches high. Water is at first used sparingly, but the surface is flooded when the rice attains a height of six to eight inches. As in the case of the river rice the fields are continuously flooded from this time until shortly before the crop is harvested.

In the river districts of Louisiana the water required is obtained by siphoning it over the levees from the river, or, in case of low water, from pools into which it has been pumped. In the prairie districts large canal systems, supplied by pumping plants, Figure 2, and irrigating extensive tracts are common. The pumping plants operate against heads ranging from ten to seventy feet, and are made of sufficient capacity to furnish seven to eight gallons per minute for each acre irrigated. One cubic foot of water per second would thus serve about sixty acres of land.

Modifications of the check method of land preparation prevail throughout the rice districts. In the past the levees were far apart, but later practice has fully demonstrated the advantages of having three to five contours in each foot of vertical elevation instead of only two, as was the former custom. This allows a corresponding reduction in the height of the levees and the size of the checks. The lesson which experience has taught in the rice fields of the Gulf States, as well as in the San Joaquin Valley of California, is that the low levee with a broad, evenly trimmed base is best, and presents the least obstruction to farm operations.

Stated generally, alfalfa is irrigated by flooding in the Rocky Mountain States, from furrows in the Northwest and in borders and checks in the Southwest and California. The amount of water, usually designated the "head," required for flooding varies from fifty to two hundred miner's inches. This quantity is conveyed to the highest point of the field in a supply ditch and is there divided among two or more field laterals, the number served depending on the total head. The least head for any one lateral is seldom less than forty inches. When water is admitted into a lateral it is checked at a point 100 feet or more below the place of entrance. These checks may be earth, coarse manure covered with earth on the up-stream face, canvas or wood. The effect of any one of these checks is to raise the water until it flows over the low places or through openings made with a shovel. This partial flooding and absorption by the soil is shown in Figure 8. Any excess water is caught up by the next lower lateral, and when the soil is thoroughly soaked to a depth of about twelve inches the check is either broken or removed to a point lower down and the flooding of the adjacent piece of land is

begun. One man can water from about two to five acres in twelve hours.

The fine soils found in parts of the Northwest have a tendency to run together and form a crust after water is spread over the surface. In order to prevent puddling and baking, which injure crops, the soil is moistened from furrows. The spacing of the furrows varies from twelve to forty-eight inches, depending on the readiness with which the water moistens the dry earth on each side of the furrow. The furrower shown in Figure 15 or some modification of this implement is used to make the furrows. Water is turned into these from head ditches, usually through spouts or tubes, Figure 12. When a field is properly prepared the task of irrigating by this method is easy. In sandy loam, and with furrows 500 to 1,000 feet long, the water is allowed to run for about two days. At first a larger head is used, but after the bottom of each furrow is wet a smaller stream will suffice.

In irrigating alfalfa in checks, Figure 9, large heads are the rule. In the Modesto and Turlock irrigation districts of California ten or more cubic feet per second is commonly used. With this head three or four checks, each averaging about three-fourths of an acre in extent, are flooded at one time, and in ten hours it is possible to irrigate sixteen acres to an average depth of six inches. With such facilities for distributing and controlling water the wetting of the soil becomes an easy and simple task.

In irrigating alfalfa in borders in the Yuma Valley, Arizona, a head of about four cubic feet per second is divided between three or four borders, and the time required for the thin sheet of water to traverse a field forty rods long depends on the slope, soil, crop and thoroughness of irrigation desired. The usual time is one hour.

Grain occupies an important place in irrigated farming. Such crops as alfalfa, beets, potatoes and fruit give much greater returns, but grain growing must needs be practiced to round out the requirements of most diversified farms

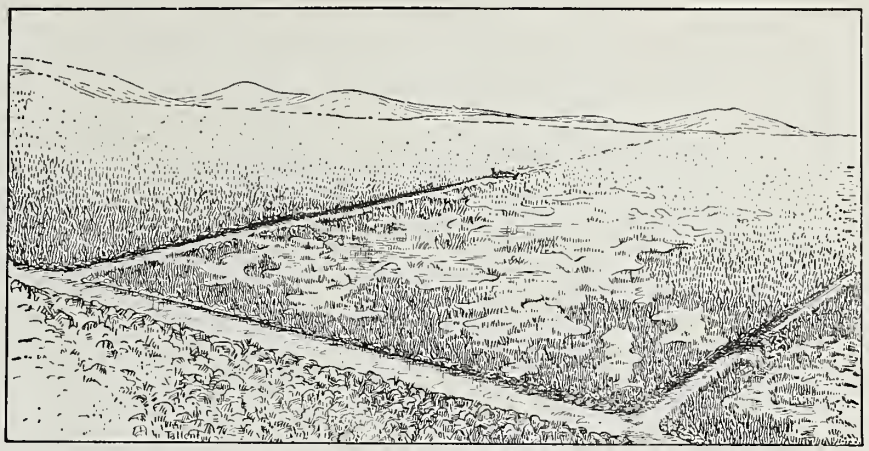


FIGURE 8—FLOODING FROM FIELD LATERALS

under irrigation. To the new settler with little means it brings in quick returns; it is one of the best preparatory crops to sow on raw land, and it fits into the ordinary crop rotation of the West made up of grain, alfalfa and sugar beets or potatoes.

Grains of all kinds are irrigated mostly by the flooding method, Figure 8, but borders and furrows are also used to a limited extent. The process of flooding grain fields from field laterals is very much the same as that for alfalfa, except that the laterals are spaced closer. Less care is likewise taken in forming these channels, since they are not intended to last beyond one irrigating season. After the last watering, and before the grain is ready to harvest, the field ditches are filled in so as not to interfere with the reaper.

In the Yakima Valley in Washington grain is irrigated from furrows spaced twenty-four to thirty inches apart, and in the Imperial Valley in California it is flooded in borders about fifty feet in width, and often a quarter of a mile long.

The low duty of water on grain land is largely due to the newness of the ground and the rough condition of the surface. Results of measurements made in different states of the West show that large quantities of water, often exceeding six acre feet per acre, are frequently applied to grain fields. It is apparent from the low or average yields obtained that the greater part of the water is wasted. Under skillful use more than two acre feet per acre is seldom needed.

The growing of sugar beets under irrigation is highly profitable when a heavy tonnage can be secured. To accomplish this desirable end alfalfa fields are frequently plowed under to make way for sugar beets, and when no rotation is practiced the best soil is usually selected for this crop. Perhaps the best soil for sugar beets is a well drained clay loam, with just enough sand or silt in its composition to work freely. Deep plowing is essential, and as a rule it pays to subsoil. The two operations loosen the soil to a depth of fourteen to sixteen inches. Outside of California sugar beets are irrigated by furrows. These start from a head ditch running across the upper margin of the field and extend down the steepest slope, or diagonally if the slope be too great. The furrower shown in Figure 15 may be used to form the furrows, provided the runners are spaced to correspond with the beet rows, and also provided that the soil is loose and free. Shovels attached to cultivators are, however, the most convenient implements for this purpose. It is well nigh impossible to distribute water evenly in long furrows, and for this reason their length should not exceed a general average of 350 feet. Fields that are 600 to 1,000 feet long should be provided with at least two head ditches, the lower one acting as a drainage channel for the upper half of the field and a supply ditch for the lower half.

Deep plowing, thorough cultivation, leveling, grading and furrowing should all be done with skill and care, but none of these is so difficult to manage as an even distribution of the water among the furrows. In perhaps ninety per cent of all beet irrigation too much water is forced into some furrows, resulting in flooding parts of the crop, which invariably suffers in consequence. Some device like those shown in Figures 12, 13 and 14 should be used to regulate the quan-

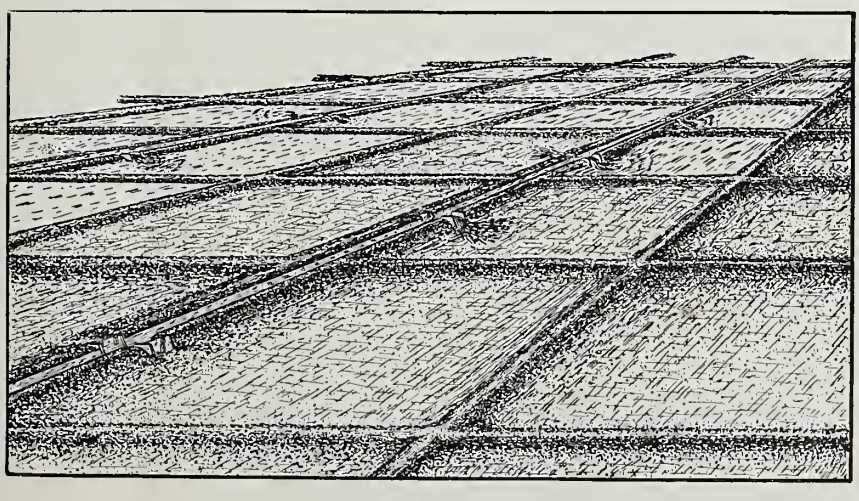


FIGURE 9—CHECK METHOD OF IRRIGATION

tity of water entering each furrow. Each small stream should then be allowed to run until the absorption which goes on in its passage down the furrow has sufficiently moistened the soil around the roots.

As regards the right time to irrigate and the proper quantity to apply the best guide is a close observance of the crop itself. Sufficient moisture should be given to the soil to enable the beets to maintain a steady, vigorous growth. When water is applied too early it produces leaves at the expense of roots, and too late waterings cause the plants to mature before they have their growth. A depth of four to five inches over the surface is usually applied at each watering, and the number of applications ranges from two to four in a season, the ground being cultivated as soon after each irrigation as practicable.

The growing of potatoes in a commercial way in some of the arid states is rapidly becoming an important industry. Its success is largely due to an interchange of other irrigated crops. A common rotation on the more fertile bench soils of Greeley, Colorado, consists of grain as a nurse crop to alfalfa the first season, then two years of alfalfa, followed by two years of potatoes. In the San Luis Valley of Colorado the common field pea is substituted for alfalfa, the most common rotation being one to two years of peas, one to two years of potatoes, followed by one to two years of grain.

The rotation of crops in potato growing has an important bearing on the way in which the fields are prepared for irrigation and the manner of applying water. Neither the check nor the basin method is suitable, since potatoes cannot well be flooded. The choice lies between furrows and flooding from field laterals, since it is easy to change from the flooding method followed in alfalfa, peas or grain to the furrow method followed in potatoes. In furrow irrigation the size of the field, the slope and the character of the soil cause the length of the furrow to vary from a minimum of 200 feet to a maximum of 1,400 feet. From the standpoint of the irrigator it is not advisable to increase the length beyond 660 feet. Sometimes the furrows are not more than six inches deep, at other times they are twelve inches deep. A common practice is to have the bottom of the furrows about twelve inches below the crown of the plant. In most other respects the irrigation of potatoes does not differ from that of sugar beets.

Gently sloping land is preferred for irrigated orchards. A fall of ten to twenty feet to the mile insures good drainage, and the soil is not eroded by small streams of water. On very flat slopes the excess water from irrigation frequently has to be removed by artificial means, and on very deep slopes the difficulties of applying water are greater.

Furrow and basin irrigation are the usual methods employed, but the former is more common. In setting out land for commercial orchards a section is usually divided first into forty-acre divisions and then into ten-acre tracts. The lateral ditches supply the divisions, and individual owners control the respective tracts. When the width of driveways is deducted the length of a tract occupied by trees is seldom more than 600 feet. This distance governs the length of the furrows. The watering of orchard trees during the first season after transplanting is most commonly done through two furrows spaced four feet on each side of the tree. As the roots expand more furrows are added, and about the time the tree begins to bear the entire space between the rows is moistened, the number of furrows necessary to accomplish this depending on the soil, depth of furrow, cultivation, etc. Evaporation is less from furrow than from surface irrigation, and deep furrows conserve more water than shallow furrows. In citrus orchards, where water is valuable, a depth of furrow of eight inches is common.

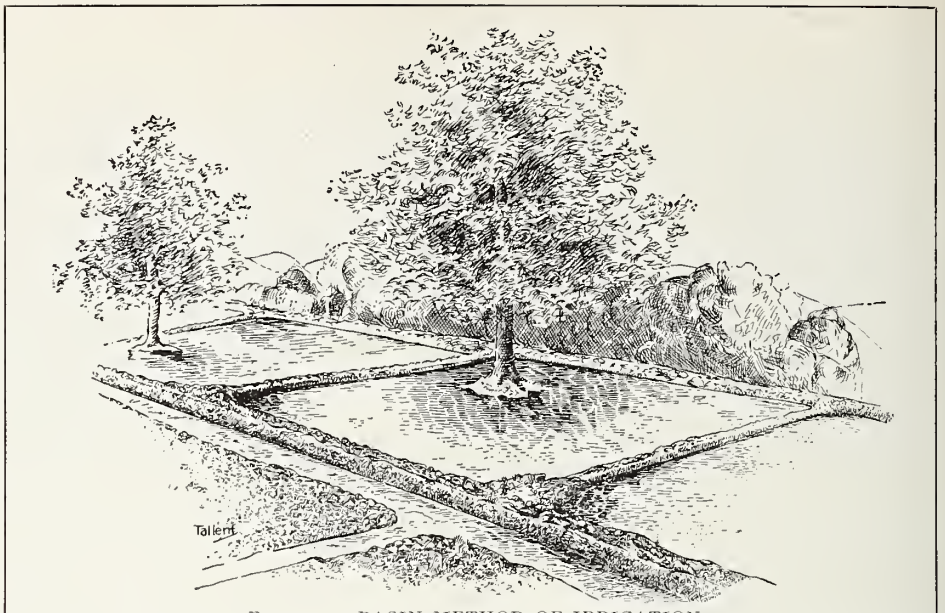


FIGURE 10—BASIN METHOD OF IRRIGATION

In conducting a supply of water along the upper margin of an orchard and in distributing the flow evenly among a large number of furrows, various plans have been adopted. Although the earthen ditch is still common it is no longer regarded with favor. Wooden spouts, Figure 12, or short lengths of pipe inserted in the lower bank of the feed ditch are cheap and fairly effective. Wooden flumes, Figure 13, with auger holes about one inch in diameter spaced every four feet are quite effective, but the wood soon deteriorates, and in time decays. The cement flume shown in Figure 14 overcomes this objection, but both interfere with the free use of teams. For this and other reasons many orchardists prefer to conduct the water in a pipe and bring it to the surface through a short standpipe located at the head of each row of trees. This system is shown in part in Figure 16. Each standpipe, through the small openings made in its shell slightly above the ground surface, can supply all the furrows belonging to any one row of trees without interfering to any appreciable extent with the free passage of teams.

The quantity of water that is applied to orchards during an irrigation season runs all the way from one to five feet. Where more than three feet in depth is used it is pretty safe to conclude that the excess is wasted. In districts of scanty rainfall and heavy evaporation, the most profitable crops are produced with the use of twenty to thirty inches in depth over the surface throughout the season. One of the most productive apple orchards in the vicinity of Wenatchee, Washington, is irrigated five times between the middle of May and the last week in September, from four to five inches in depth being applied at each watering. In Southern California it requires fully three inches per month in depth over the surface, including both rain and ditch water, to keep citrus trees in a good condition. For the past seven years the amount of irrigation water which has been applied to the lands under a canal at Riverside, California, which serves about 9,000 acres, has averaged twenty-seven and three-quarter inches in depth over the surface. The average rainfall of this locality for the seven years was ten and one-half inches, thus making the total thirty-eight and one-quarter inches, or a trifle more than three inches per month.

In the introductory paragraph of this article it was estimated that the water now diverted from stream channels and other sources in excess of that required to produce satisfactory yields is sufficient to irrigate 7,000,000 acres of land. Very little of this excessive use is deliberate waste. A large part of the water taken from natural streams is lost before it reaches the fields of the farmers and another large part of it results from the failure to adapt methods to soil and crop conditions and to the character of the water supply. In deciding upon the best method for given conditions all these factors must be considered, and the crop and the soil should be examined often to see whether the water is being properly distributed to the plant roots.

MOST PROFITABLE USE OF OUR WATER SUPPLY

BY S. O. JAYNE, IRRIGATION MANAGER U. S. DEPARTMENT OF AGRICULTURE

A RECENT PUBLICATION issued by the State Bureau of Statistics says: "It is quite within the range of possibilities that the products of the irrigated lands of Washington will in time exceed in annual value the present output from our combined timber and cereal producing areas." According to the same authority the forest and grain products aggregate not less than $100,000,000 in value each year. To expect so much from irrigated lands may seem very optimistic, but I do not consider it unreasonable. But whether or not the products of irrigation ever reach the figure given there can be no question that the future development of agriculture in the State of Washington will depend as much, or more, upon a judicious use of our water supply than upon any other factor.

There are millions of acres of land in Eastern Washington most admirably adapted to irrigation farming so far as soil and climatic conditions are concerned; in fact there is scarcely an acre of ground or a farm which would not, with the skillful use of water, yield much larger and more profitable crops than can be grown by dry farming methods or by depending solely on the natural precipitation. And not all of the land adapted to irrigation is in the eastern part of the state. Over west of the mountains there are many districts of considerable extent which would be wonderfully benefited through irrigation, though the fact is only beginning to be realized.

We have at the present time less than 500,000 acres under ditch, and I believe less than 300,000 acres actually irrigated. It is conservatively estimated that we have four times the former figure, or 2,000,000 acres irrigable, but as to what part of this or how much more will eventually be irrigated no man knows. But certain we are of this, that our available land many times exceeds the amount of available water, and we know that the greater the area that our available water can be made to efficiently irrigate the greater will be the wealth and general benefit to the state.

With this knowledge, then, it is pertinent and timely to determine whether existing methods and agencies affecting the use of the water supply are such as will guarantee the maximum duty. If present conditions are not favorable to best use along what lines and in what way can improvement be brought about?

To discuss in detail all the many and varied influences bearing upon the subject is, however, not permissible here, and an attempt will be made to consider only a few of the most important.

In the disposition of public resources of value, such as our water supply, there should be in the beginning adequate laws or provisions to regulate its appropriation and insure its proper use. Not to maintain such supervision is like giving a large family of small children free access to the sugar barrel.

The sugar would disappear very rapidly. There would be abundant evidence of use, but no record as to how or where. There would be waste, over-indulgence, internal ills, doctor bills, and doubtless bickerings over possession of the biggest lumps. Now, the people of this state have for the past thirty-five or forty years been running to Mother Washington's sugar barrel, or, more literally, to the water barrel, with practically no restraint beyond the individual will. Appropriations have been made out of all proportion to the physical needs; some has been used, much has been wasted. There has been over-indulgence, and the internal ills are evidenced by the breaking out of alkali. Over on the reservation we have a doctor bill of $150,000 for a capital operation in the way of an eighteen-mile drainage ditch; at Richland another for $40,000; in the Moxee, on Nob Hill and at Sunnyside already large sums have gone to pay the price of folly and misuse, and the end is not yet. At times of shortage there have been the to be expected bickerings over possession of the biggest share, and expensive litigation is still going on. Official records of use are almost entirely lacking and of little value. Outside of the Yakima Valley perhaps not one ditch in a hundred has ever been actually measured, and no one knows how much water is being used, or with what efficiency.

State supervision over the character of irrigation development there is practically none at all. Anyone, be he so inclined, may place a few miles of cheap pipe on a piece of cheap land, connect a cheap pumping plant, print an expensive book showing beautiful and profitable orchards and proceed to sell out to innocent Easterners for whatever price his conscience will stand for, and there is no authority to say him nay. It is legitimate business. But it is not fair to the purchaser, to the honest promoter, nor to the state. Such a condition of affairs is in every way inimical to best use of the water supply, and it certainly is time for Mother Washington to assert her prerogatives, lay down some better law and assume her responsibilities in the matter.

One of the prevalent sources of waste throughout the state has been, and still is, the seepage from poorly constructed ditches and canals. To this cause, in a measure, also is due the waterlogged condition of much of the land now requiring drainage. The magnitude of the annual loss occurring in this way is not generally known or appreciated. Measurements made by the irrigation investigations of the Department of Agriculture during the past few years on a great many canals show an average loss on main canals of about one per cent for each mile that water is carried; on laterals the losses amount to eleven or twelve per cent, while on some California canals the loss in a single mile is sixty-four per cent, and we have some that can probably leak as fast as any in California.

On one of the larger canals at the lower end of the Yakima Valley, in 1906, there was found to be a loss of twenty-five and two-tenths per cent in a distance of less than nine miles, and the total amount lost from the main canal was estimated at over fifty per cent of the water taken in at the head. One of the Spokane Valley canals showed a loss in 1907 of forty per cent in about three miles. The Sunnyside canal, the largest in the state, constructed almost entirely in earth of fine texture, loses, according to estimates, fifteen per cent in the main channel and an equal amount in the lateral system, making a total loss of thirty per cent of the water diverted from the river.

The waste from the Sunnyside canal from this cause is less than the average. If all the canals of the valley or of the state be considered it is doubtful if more than fifty per cent of the water diverted from the streams ever reaches the fields. But assume that the Sunnyside canal is representative and that thirty per cent is a fair estimate of the total loss in transit, (the total average diversion from the Yakima River and tributaries during August, 1905, amounted to approximately 2,000 cubic feet per second,) then on the basis of our assumption the waste from seepage would be 600

FIGURE 11—BORDER METHOD OF IRRIGATION

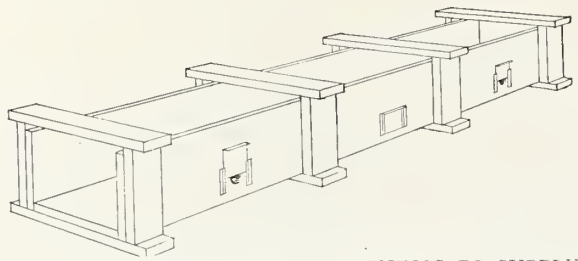


FIGURE 13—HEAD FLUME WITH OPENINGS TO SUPPLY WATER TO FURROWS

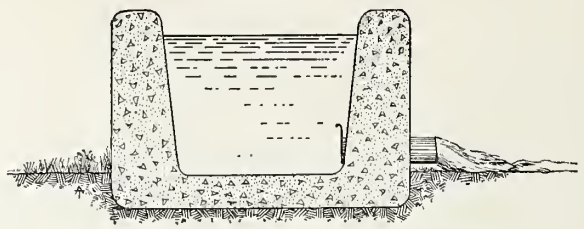


FIGURE 14—SECTION OF CEMENT HEAD FLUME

cubic feet per second, water enough at the rate of a second foot per 160 acres to supply 96,000 acres of land, or nearly twice as much as was watered by the Sunnyside canal in 1910.

With water rights valued at $100 per acre, which is materially less than many have been sold for in different parts of the state, this water would be worth $9,600,000. This amount of land in its raw state, with water right, would at present prices be worth $20,000,000 to $35,000,000. The foregoing is illustrative of conditions in many parts of the state, and should be sufficient argument in favor of better construction, which will be necessary before the most efficient use of our water supply can be realized.

At the time most of the canals of this valley were built no better construction, as a rule, was possible or justified by existing conditions. The prime object was to get water on the land. So long as there was an abundance in the stream a loss of fifty per cent or more by seepage from the ditches was a matter of small concern, and to have considered structures of masonry or concrete, or lining canals with cement at $10 per barrel would have been ridiculous. The history of this valley has been repeated in most of the other districts, and the pioneers in canal building and irrigation did well and deserve great credit for what they did. But conditions now are not what they were twenty-five years ago, or even five years ago. The general development in this and other of our irrigated districts has been marvelously rapid—almost beyond our power to realize. The old leaky and temporary wooden flumes and other structures have served their purpose, and have about had their day.

We are now, I believe, in the beginning of a new epoch in irrigation development, one in which the methods and practices of the earlier days will have little part. We are ready to build for the ages, and a start has been made. Some of the works that have gone in during the past five years should be in service a thousand years from now. At Clarkston and some other places the open ditches have been abandoned and pipe lines substituted at great expense, thus eliminating seepage losses altogether. Several of the irrigation companies have begun to line their canals with concrete, and more of it will be done each year until finally a large percentage of the irrigation ditches all over the state will doubtless be rendered water tight in this way and the present waste from seepage stopped or reduced to a minimum. Besides the saving of water there would be other important benefits and objects in lining the channels. The danger from disastrous breaks would be reduced, less inspection and fewer patrolmen would be required, the common trouble and expense due to the growth and necessary removal of aquatic plants would be eliminated and the growth of clover, willows, thistles and other noxious weeds, usually found to be a nuisance along canal banks, would be largely prevented; all tending to materially reduce the cost of maintenance and operation.

In building the more important systems, such as the Yakima high line, the Horse Heaven canal and others of this class, concrete lining will be generally considered as a necessity, but improvement of existing canals is going to be a matter more difficult of accomplishment, especially where all the land under them is developed and there is no opportunity for the owners to make use of water on other land. Though the lining would save thirty to fifty per cent of the water diverted from the streams and make it available for other lands the owners will not voluntarily go to the expense of making the improvement, and there is now no means of compelling them. Future legislation will doubtless prevent the acquirement of rights so large that the appropriator can afford to waste it in transit, and it would seem only fair to the state to make provision also whereby water which has already been acquired materially in excess of a reasonable need can be condemned, and used where it will do most good.

In many places a much better use of water would obtain by abandoning small parallel ditches and combining the flow of all in one well built canal, under a single management. By improvement, also, in systems of ditch management great savings of water are possible. The practice, for instance, of measuring all water to consumers, as has been done on the Prosser canal and a few others for several years, would, if generally adopted, result in a much more economical use.

While the waste of water from canals and distribution ditches, everywhere apparent, must be checked before best use is attained there are other ways of misuse, less evident but equally great, equally in need of correction and much more difficult to control. These are associated with the application of the water to the land, and consist principally in surface run-off, evaporation from the surface of the soil and deep percolation into the subsoil. The first is due in part to the steepness of much of the land irrigated and largely to careless handling of the water and lack of attention; the excessive evaporation results chiefly from lack of cultivation; percolation losses, the most serious of the three and most difficult to appreciate and control, are occasioned generally by the combination of shallow or very porous soil and subsoil, and a lack of skill on the part of the irrigator.

Much has been said and written as to methods of reducing these losses, but the degree of success will in all cases depend upon many variable conditions, and into the problem the personal equation will always enter as one of the most important factors. We may line the ditches or pipe the water to the land, and know when we have reached the limit of economy in conveyance, but who can say when we have reached the limit as to its use on the farm.

This brings us to the question that is ever being asked and never answered. How much water is required, maybe for alfalfa, for potatoes, for garden truck; but here most often it is: "How much water is required for the commercial orchard?" This question as to the actual water requirements of crops, or rather as to the best possible use of the water in their production, is the most important and at the same time the most complicated and difficult problem that we have to solve in connection with irrigation. The actual amount of water that enters into the growth of a plant, or is transpired in the production of one pound of dry matter, is nearly constant, and may be determined with a fair degree of accuracy, as has been done in the case of many of our farm crops, but under field conditions some additional allowance must be made to provide for other necessary losses, which vary widely with differences of soil, climate and tillage.

"An inch to the acre" was the rule in the early days, which amount, continuous flow for seven months, is equivalent to a depth over the surface of nearly ten feet. Experience and better farming have demonstrated fully that for most conditions this was an excessive use, and contracts made in more recent years have stipulated much smaller quantities. A second foot per 160 acres continuous flow for a period of seven months, amounting to thirty-two inches in depth, has been a common allowance specified by many irrigation companies, while some few do not give so much, and one at least limits the use to six inches for the irrigation season.

But water contracts are but arbitrary assumptions as to the requirements of crops, and where we find that in one district thirty-six to forty inches is the assumed duty, according to contracts, while in another a few miles away, with conditions still more arid, it is placed at eighteen inches for the season, it is safe to assume that someone's assumptions are inaccurate. If eighteen inches is sufficient, then what a lack of economy there is in supplying thirty-six to forty; while if thirty-six inches of water is necessary, those who buy land and expect to succeed with eighteen inches are doomed to disappointment. With water abundant, as we have known it in the past, the tendency has been common to overestimate the quantity needed and to be ultra-liberal in allotting the supply, but with scarcity or the necessity of pumping it at great cost in the none too distant future, there is apt to be a stronger tendency in the opposite direction. Both extremes are opposed to best use, and should be equally guarded against.

As water contracts and court decrees are not to be considered reliable evidence in judging the amount of water needed, we must have something better as a basis of determination. The only safe guide is accurate scientific information which comes from actual practice. It is not wise to assume a duty appreciably higher than has already been attained. For example, if no one has ever grown a good commercial orchard on less than eighteen inches of water, to attempt it with half or two-thirds of this amount is nothing more than an experiment, and to invest large capital on such an expectation is a gamble. Let us see, then, what has been done.

Records of the water used by the Sunnyside canal system have been kept since 1898. The general duty that year for all lands was 11.4 feet in depth over the surface. In 1906 the general duty was shown to be 6.5 feet, and during the season of 1910 the depth of water received by the land was three feet. The general duty in the Moxee Valley under the Selah-Moxee canal in 1906 was one second foot per 104 acres irrigated, or a depth of 3.48 feet. That same season water was used on the Kennewick garden tracts to a depth of 6.31 feet.

Farmers' bulletin No. 404 of the United States Department of Agriculture states that the most reliable and in many ways the most valuable records pertaining to duty of water on orchards have been obtained from the companies of Riverside County, California. Here more or less irrigation water is used every month of the year. The average duty for the Riverside Water Company for a period of seven years was 3.3 acre feet, including rainfall. Dr. Fortier, the author of this bulletin, states that with the same degree of economy here in Washington twenty per cent less, or thirty-two inches, should be sufficient. The lands irrigated by the California company just mentioned included 6,000 acres of orange orchard and 3,000 acres of alfalfa. Professor E. J. Wickson, in farmers' bulletin No. 116, states that evergreen fruit trees, including citrus fruits, require about fifty per cent more water than deciduous fruit trees under same conditions, and that with adequate depth and retentiveness of soil twenty inches of rainfall, if duly conserved by good cultivation, may render irrigation unnnecessary for deep-rooting deciduous fruits. In the eastern part of this state we find commercial orchards being grown without irrigation where the annual precipitation is twenty-three inches, about one-fifth of which runs off, leaving eighteen inches for the trees. But this amount is insufficient to give yields comparable with those from irrigated orchards, and we know that additional water would be beneficial.

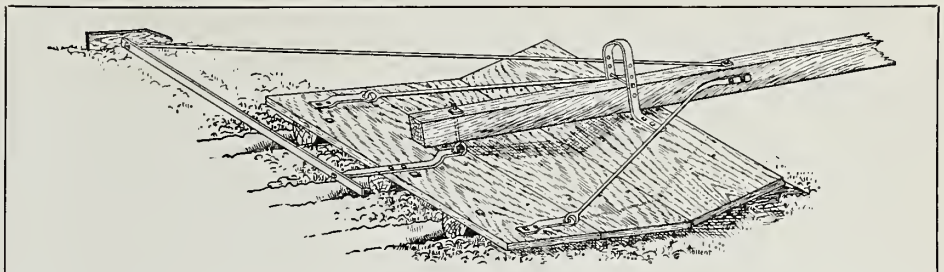


FIGURE 15—FURROWER

The water on a twenty-acre apple orchard at Wenatchee was measured during the season of 1908, showing that a depth of 23.04 inches was applied between May 13 and September 23. On the same orchard in 1910 twenty-seven inches of water was used, the first irrigation being May 30 and the last September 12. To this amount in each year should be added the rainfall to the extent of possibly six inches, making a total of twenty-nine inches for 1908 and thirty-three inches for 1910. The trees were seven years old in 1908 and bore a heavy crop that year, another in 1909 and another last year. The orchard is one of the best cared for as well as one of the best producers of the Wenatchee district. The irrigation was done with more than the ordinary intelligence and care, but the soil texture is rather coarse and the water-holding capacity low, thus being favorable to large percolation losses into the subsoil. Undoubtedly a considerable saving in water would have been possible had the furrows used been only 330 feet long, instead of twice that length.

Another Wenatchee orchard of fifty acres, including apples, peaches, cherries and other fruits, used in 1908, according to measurements, something over sixteen inches, and in 1910 17.5 inches, rainfall not included. The soil here was perhaps somewhat heavier than in the former case, but the furrows used were twice as long, and besides the run-off was considerable. Part of the orchard, however, was not in bearing, and none of it so uniformly good as the other example cited. The records of one of the Spokane Valley companies show that on that system a depth of 14.7 inches was applied in 1905, 19.2 inches in 1906, 22.8 inches in 1907, and 17 inches in 1910, the rainfall in addition averaging about twenty inches per year.

So we have some data at last as to what is actually being used by a few, but what everybody uses ought to be known and on record. However, even if we did know the exact amount used annually on every single orchard, on every alfalfa field, on every potato patch throughout the entire state, it would still be a legitimate question to ask how much is best. It would be well for every irrigator to first determine how much is used, and then how much this can be economically reduced.

If we limit the use too much, smaller yields will result, but this might be possible or even necessary to best use, for a maximum yield per unit of area does not always imply most economical use of the water, as for instance, in one Utah experiment twenty inches of water produced a yield of 446 bushels of potatoes, while increasing the water to forty inches gave 523 bushels. It was evidently not best use to apply the second twenty inches just to get the additional seventy-seven bushels, when it could have been used on another piece of ground to produce 446 bushels, or, in other words, it would have been better to have had every acre in that section yielding profitable crops rather than only half of the acreage yielding maximum crops.

The time will never come when we can arbitrarily fix the duty of water for orchards or other crops and expect it to apply everywhere. It is possible, however, to take given conditions and determine the water requirements within reasonable limits, present knowledge indicating that on deep, fine soil, such as

FIGURE 12—CHECK IN HEAD DITCH AND DISTRIBUTION OF WATER THROUGH WOODEN TUBES

is found more or less generally throughout the Yakima Valley, for instance above the Sunnyside canal, twenty-four inches of irrigation water, or possibly less, will produce orchards, assuming that waste is reduced to a minimum by careful application and thorough cultivation.

This type of soil will hold about 23 per cent of moisture, or nineteen inches in the first four feet. Where it is eight, ten or possibly fifty feet deep, as is not uncommon, there is no excuse for waste water by percolation into the subsoil, for trees are able to get moisture from the depth of eight to ten feet. With the same type and depth of soil at Wenatchee or some other part of the state having a greater rainfall, less irrigation water would be necessary.

Now, if the soil is but eighteen inches to three feet deep, as we will find it in some sections, or coarser in texture, it is impossible to use water with the same degree of economy as on the fine, deep soils, for the reason that a larger percentage is lost by percolation into the subsoil, and more by evaporation occasioned by the greater frequency of irrigations necessary. On soils of this kind humus should be added by every possible means to increase the water-holding capacity, if for no other reason, and if manure is not available, this means cover crops in the orchard.

In fact, since the practice of growing cover crops is coming to be so generally adopted, its influence upon the water requirements of orchards must be considered, for the two crops cannot be grown on the same ground at the same time without requiring more water than for one. To grow one ton of clover hay per acre about five inches of water is required, allowing nothing for any loss by percolation or run-off; alfalfa needs about the same. So if either clover or alfalfa is to be grown with the trees, five inches or more per acre of irrigation water will have to be added for each ton of dry matter produced. In the light of present experience it is unwise not to make provision for growing such crops to some extent at least in connection with every orchard scheme.

There are other matters bearing on the question of best use that have as yet received scarcely any or perhaps no consideration whatever. Bulletin 101 of the Oregon Agricultural College experiment station says: "It is not sufficient merely to obtain fruit of a certain size, but such questions as the relation of irrigation to color, flavor and shipping qualities of the fruit, the action of the water on the leaf, twig and bud, and the action of the water on the different types of soil, must be considered." Different kinds of fruits, we know, too, require varying amounts of water, even different varieties of the same species may not respond uniformly to like irrigation. It is said that the Spitzenberg apple, for instance, if kept too moist will be inclined to go too much to wood growth, and will not set fruit spurs without summer pruning.

The time of applying water, too, in the production of fruits may have as much influence on yield and quality of the crop as does the amount applied. It has been demonstrated that in growing peaches heavy irrigation early in the season, followed by a more moderate or light use of water later, produces strong wood growth in the tree, and a peach with large stone and comparatively little flesh, while light early irrigation, followed by a copious use later, gives less wood growth and a peach with stone much smaller in proportion to the fleshy part. The flavor and keeping quality of the latter will, however, be inferior to peaches grown by the opposite method.

We must conclude that the problem of how to make the best use of our irrigation water is one of great breadth and depth, involving many things in its solution. The attainment of best use will depend on how well we as citizens practice what we already know to be right use, and to a large extent also on knowledge yet to be acquired, for there is yet much to learn.

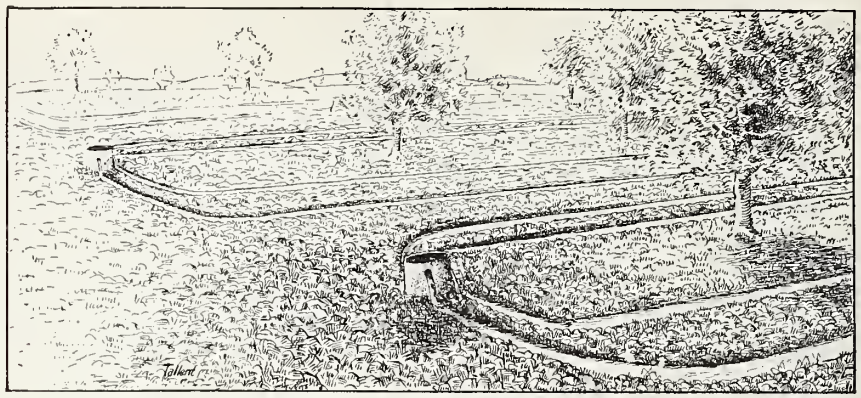


FIGURE 16—STANDPIPE SUPPLYING WATER TO FURROWS IN ORCHARDS.

FROM OUR APPECIATIVE SOUTHERN SUBSCRIBERS

YOUR instructive and beautiful "Better Fruit" reaches us away down here in the Piedmont region of Georgia, where conditions are so entirely different from your section; yet, we think, in many respects "the fruit section of U. S." Whilst the apple and the peach have been growing here for over 100 years—as the Cherokee Indians had planted quite a number of orchards and had been our first fruit men of the northeast of Georgia.

The early settlers, in 1824 to 1840, brought in fruit trees from their home section and planted trees until today these veritable monarchs of the apple and peach stand as curiosities. We have apple trees three feet in diameter, forty to fifty feet high and producing forty to seventy-five tons of apples. An old peach tree on my farm is now forty years old, and the natives say fruit has been gathered from it for nearly its entire life, and never a flat failure.

A cherry tree eighteen inches in diameter sends bushels of fine cherries to market at Atlanta yearly, netting the owner $40 to $70.

Twenty-six different varieties, including all the leading varieties of berries, ripen and pay well here. Sixteen different kinds of nuts, including the paper-shell pecan and English walnut. Yearly more and better varieties of fruit are being planted, for our country is only eight of ten years old as far as commercial fruit industry is concerned—one might say a recent discovery. A few energetic people have literally taken hold and shaken up this section, buying some 10,000 acres, and have about half planted in peach and apple orchards already shipping 500 cars annually.

Our peach orchards commence to bear at two or three years of age after planting, usually paying for themselves in three years. Apple orchards, mostly young, are paying from $200 to $500 per acre net; larger income when older. Our market lies right at our door, netting $1 to $2 per ton f. o. b. Cornelia.

I sent thirty-three different varieties of apples to the government pomologist. He did not know half of them—so many new varieties seem indigenous to this section—some of them superior to the Jonathan and Baldwin.

The rainfall is sixty-five inches annually, plenty of cheap white labor, and Habersham County, of which Cornelia is the center of the fruit belt, is, according to the U. S. census of 1890, the healthiest county in the U. S.

We would be glad, Mr. Editor, to show you our section, where heaven supplies the perfect climate for fruit.

California is a wonderful state, famous for its generosity and its hospitality. Citizens of San Francisco subscribed for this exposition $7,500,000, $4,000,000 of which was raised in two hours. The State Legislature voted $10,000,000 more. This means that California will put up $17,500,000 for this exposition, which will make it the greatest and grandest exposition ever held in the world. The entire Pacific slope, including the Northwest, should support San Francisco in this exposition in every way possible for the great good and benefit which will come out of it for the entire Pacific slope and the Northwest.

ROOT DISEASES CAUSED BY ARMILLARIA MOLLEA

BY W. H. LAWRENCE, WESTERN WASHINGTON EXPERIMENT STATION, PUYALLUP, WASHINGTON

DURING the past three years a large number of inquiries have been received concerning the death of individual fruit trees among many apparently healthy ones, also groups or hills of bush and other small fruits. The examination of many of these dead or dying plants has revealed, in many instances, the presence of dark colored, cord-like bodies (rhizomorphs) on the stems and roots. After noting the nature of the injury caused by these rhizomorphs in numerous plants of various sorts, and by comparing the rhizomorphs with those of Armillaria mellea collected by Piper and Fletcher in Clarke County, and the rhizomorphs of the same species of toadstool collected by the writer in New York, the fungus was concluded to be a form of Armillaria mellea. At a later date a few mature toadstools were collected. By comparing these specimens with the illustrations and descriptions of Armillaria mellea and with Armillaria mellea bulbosa by the above mentioned authors the writer is of the opinion that at least four forms of Armillaria mellea exist in this state. Under various conditions all of these forms are more or less parasitic, and are the cause of numerous root diseases.

It is impracticable to separate the four forms into different varieties, since the botanical differences are so indistinct and variable that almost any one form would do equally well for a type specimen. The four forms mentioned include the two discussed in the above cited bulletin. The other forms occur in the Puget Sound country. One variety is delicate, small, light brown, bearing rather slender but very promiscuously branched and somewhat flattened dirty white to light brown rhizomorphs, which cover the greater portion of the substratum. This form has been collected on two occasions growing on dying blackberry cane. It will not be mentioned again in this bulletin. Since the two above named forms have been discussed at some length in a previous bulletin they will not be mentioned further. The more destructive form of those occurring in the Puget Sound country and the one discussed at some length in this article is intermediate in form between Armillaria mellea and Armillaria mellea bulbosa.

Armillaria mellea is one of the many kinds of low form of plant life which are obliged to take their sustenance from living animals, or plants, or decaying vegetable or animal matter. It consists of two parts—the vegetative and the reproductive.

The vegetative part consists of numerous thread-like strands called the mycelium. The mycelium is the sole cause of all the injury which the toadstool causes. It grows into various substances in order to collect food. Many times these threads penetrate the roots and stems of living plants. They may be confined to one or more spots of variable extent, or may infest the entire body. In many cases they are not visible to the naked eye, but under some conditions they become abundant enough to form white layers. Throughout more or less exposed places, and especially in the soil, the threads collect in cord-like strands and are enclosed by a thick black or brownish wall. These bodies are the rhizomorphs. The mycelium and rhizomorphs constitute the vegetative part. The vegetative portion has an odor similar to that of the edible mushroom.

The fruiting bodies, which are toadstools, form on the mycelium and rhizomorphs. As the vegetative portion grows it collects an abundance of food. Minute button-like bodies, which are the young toadstools, form on it. With an abundance of food in the mycelium these toadstools mature in size in a very short time. A mature toadstool consists of a stalk with a cap on the top. On the under side of the cap numerous curtain-like projections occur, which are known as gills. They are arranged around the stem similar to spokes in a wheel. On either side of each of these curtains numerous spores are produced. When the spores are ripe they fall to the ground. They are distributed by various agencies. Being very light in weight, they are undoubtedly carried long distances by the wind. When the spores lodge in places favorable to germination they produce small thread-like bodies, which, if a supply of food can be

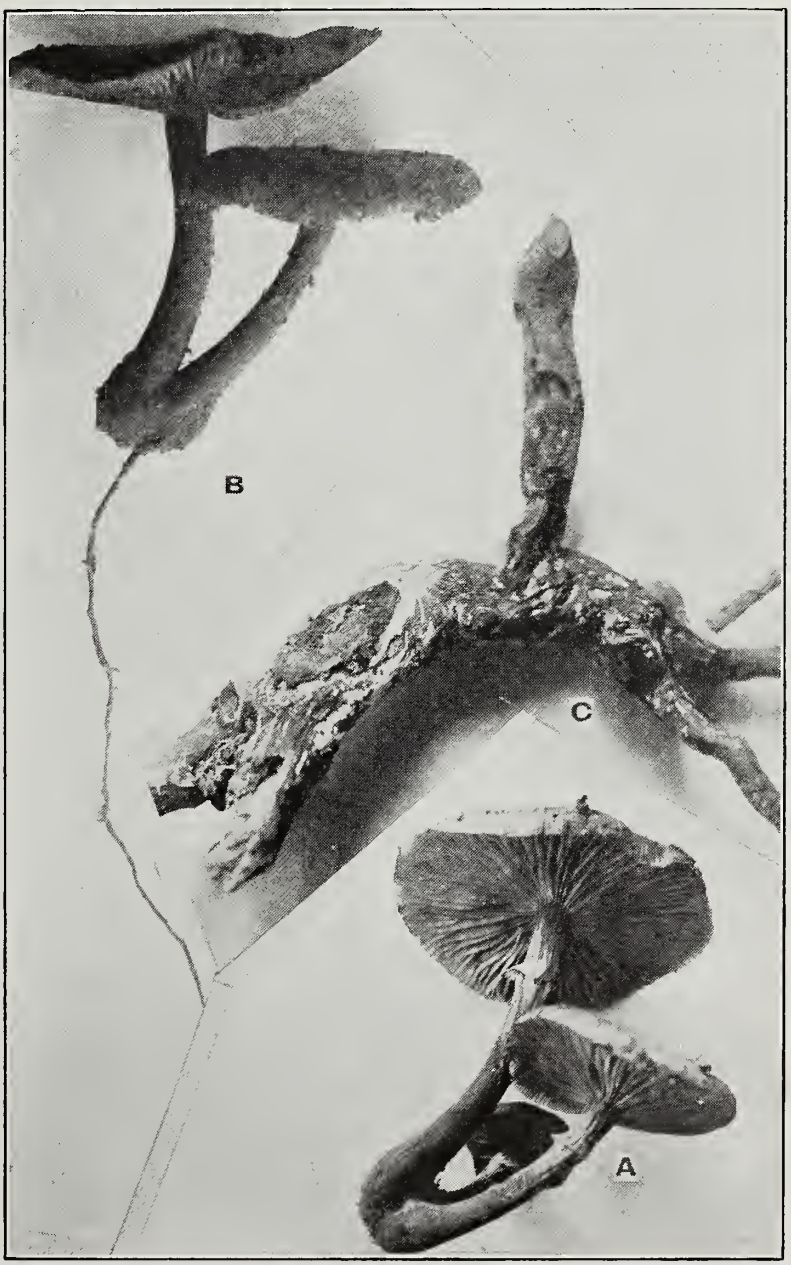


FIGURE 5—SHOWING ALL PART OF ARMILLARIA MELLEA VISIBLE TO THE NAKED EYE

A, Fruiting bodies or toadstools; *B*, Toadstools with one form of the vegetable portion (rhizomorph) attached; *C*, The mycelium, another form of the vegetable portion.

obtained, make a rapid growth. They may soon form countless numbers of delicate branches which are invisible to the naked eye, or may become abundant enough to form many white strands, white sheets or the cord-like black or brownish rhizomorphs. The formation of the toadstools on the mycelium, which in turn produce countless numbers of spores, completes the round of life of Armillaria mellea.

From a large series of observations it is concluded that the fungus is naturally a saprophyte, but occasionally becomes a semi-parasite, while under some conditions evidently becomes a true parasite. It is perhaps rightly termed a wound parasite. Many times plants are injured during cultivation. The wounds heal slowly. Occasionally the fungus gains an entrance before a wound has time to close. Small roots sometimes die and remain attached to the large one for a time. The fungus grown in the decaying roots finally comes in contact with the live wood perhaps more or less weakened by the presence of the decaying wood with which it is in contact. The fungus gradually encroaches on the live wood, which slowly succumbs to the action. The fungus thus becomes accustomed to its surroundings and continues to encroach more and more on the live portion of the plant. While digging up one small cherry tree, in which the crown and main roots had been killed for a distance of several inches, an observation was made which shows how this fungus sometimes gains an entrance. One of the main roots, although green and apparently healthy for a distance of about four feet, had a section in the center, about six inches in length, which was brown. An inspection of the root revealed several small rhizomorphs attached to the lower surface. A cross-section of the root revealed an abundance of the mycelium throughout the bark and wood. The root of this cherry tree had grown across a branch root of some plant removed during clearing. As the root decayed it became filled with the fungus, which finally came in contact with the live root of the cherry tree, the result described.

In the examination of a large number of plants, both wild and cultivated, not only a vast difference in the injury to different kinds of plants, but to individuals of the same species was evident. Two or more fruit trees, apparently killed by the same species of fungus as indicated by the presence of the rhizomorphs, would show marked differences. Some with numerous rhizomorphs growing into them, with many of the roots dead and a portion of the crown badly decayed, lived and matured an average crop of fruit.

In one instance a tree laden with a splendid crop of mature, well colored apples broke off at the crown during a slight gust of wind. In another case a large King apple failed to mature its fine load of fruit. An inspection of the roots and trunk revealed several rhizomorphs clinging to the surface of the perfectly green and sound roots. Low on the crown of this tree a few fissures, such as would naturally occur on a tree of the age of this one, had formed. The cambium layer and neighboring bark and wood, in many places, were completely filled with dense layers of mycelium, which could be easily removed to show their connection and relation with the rhizomorphs occurring on the roots. The fungus had entered through the small fissures in several places in the trunk of the tree, gradually encroached on the surrounding tissues, finally injuring the tree to such a degree that it could not mature its fruit. The tree, other than failing to produce fruit and lacking the usual abundance of foliage of so large a tree, manifested no marked injury.

Another interesting observation was made while examining a cherry tree of some seven or eight years of age that would not respond to an application of barnyard manure, irrigation and good cultivation. In examining the trunk of the tree no rhizomorphs could be seen, nor was there the slightest discoloration of the trunk and large roots, as far as could be determined without threatening the life of the tree. By an accident it was later discovered that some of the roots had been cut while cultivating raspberry plants, which were also grown in this field. By examining the roots at a distance of several feet from the trunk of the tree, several of them were found to be dead and in condition of decay. Every one of them contained rhizomorphs, which could be traced along and through the roots for a distance of several inches. Every root gave evidence that the fungus was slowly encroaching on the partially green wood.

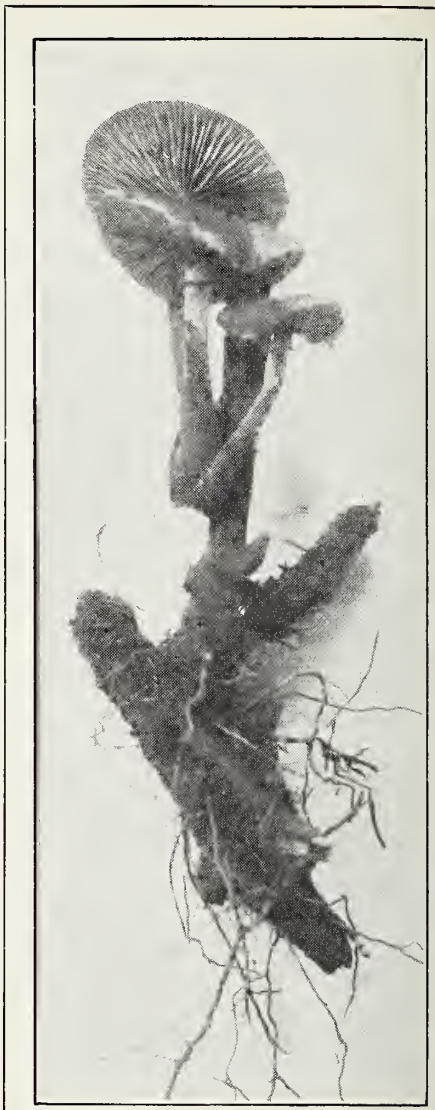


FIGURE 3—Showing a portion of the root and stem of young red raspberry plant killed by Armillaria mellea. The root shows many rhizomarphs attached to it. Three toadstools occur on the stem. These toadstools are the fruiting stage of the rhizomorphs.

In the examination of many dead or dying blackberry and raspberry plants very similar conditions to those described above were found to exist. Commonly the crowns of diseased plants were well filled with the rhizomorphs. Very frequently many of the roots were also badly infested. It was not a rare occurrence to examine plants on which the crown, though dead, had many roots that were yet green and apparently healthy a few inches remote from the crown.

In the case of such plants as fruit trees, which are grown some distance apart, only a few scattering trees in an orchard show signs of injury. In the case of bush fruits and other plants grown closely together the neighboring plants are usually affected. Rarely do single hills die or even show signs of injury without the neighboring one becoming infested. Usually one or more plants become infested, and from such places the disease spreads to neighboring plants, which later succumb. In some instances, but of rare occurrence, large groups of

FIGURE 1—SECTION OF ROOT OF BLACKBERRY PLANT, WITH NUMEROUS RHIZOMORPH OF ARMILLARIA MELLEA ATTACHED
This root was killed by the fungus

plants die at the same time. When the disease spreads from plant to plant, as it does in bush fruits, such as the red raspberry, all the plants will be killed in time unless the disease is checked or eradicated. From a casual survey of fields of bush fruits one would naturally conclude that Armillaria mellea is very destructive. A microscopic examination of the plants in such cases has shown that such loss is more commonly due to another form of fungus, which is under observation at this time, the results of which study are not ready for publication.

Since the rhizomorphs are so characteristic and so large in size, observations on the distribution of the fungus in the soil are quite readily made with much accuracy. The fungus usually occurs where decaying wood may be found. The type of soil has no influence on distribution, except as it may contain a limited or an abundant amount of decaying vegetable matter. The more humus the soil contains, and the more decaying vegetable matter in the form of limbs and roots of trees and small plants, the better the conditions for the growth of the fungus. While the fungus does occur sparingly in upland soils, the principal study of its distribution in the soil was made in low land and particularly where it had done considerable damage to cultivated plants. It is very evident that the mycelium occurs in great abundance from three to eighteen inches below the surface of the soil. Strands may be found nearer the surface, and especially when the field has not been cultivated frequently. They may sometimes be found at a depth of three feet. In a field of raspberry canes where all the plants had been killed the rhizomorphs were found extending from the dead roots of the plant out through the soil for several feet, forming a complete network by very frequently branching and rebranching.

After the discovery of the rhizomorphs in such abundance on the roots of many dead plants a careful search was made to note the general distribution of the fungus. In removing agricultural drain tile from a soil in which it had been buried not less than six years to a depth of more than two feet numerous rhizomorphs were found clinging to it. A drain box removed from another portion of the field was covered with a perfect network of the fungus. An excursion through the field revealed it on the decaying roots of stumps and logs of red fir, roots of alder, willow and cottonwood (a single specimen). On the bottom land the roots of live alders were well covered with the strands, while various kinds of decaying wood in a newly cleared but swampy field just being drained were literally filled with the mycelium, largely in the form of rhizomorphs. During the inspection of diseased and dead plants, apple, plum, cherry, prune, gooseberry, currant, blackberry, raspberry and loganberry, in many cases, were found to be badly injured or killed by this fungus. The rhizomorphs of Armillaria mellea have been observed in many localities in the Puget Sound region.

Since other forms of fungi cause root rot disease of the same plants on which Armillaria mellea grows, much difficulty is experienced in many cases in determining the real cause of the disease. In cases where the plants die without the fungus forming a conspicuous mycelium, rhizomorphs or toadstools, the cause of death can only be determined by the use of a microscope or by the employment of cultural methods. In most instances, however, identification may be made by observing the following rules:

1. Badly infested plants make little or no growth. Usually those in bearing fail to set or to mature good crops of fruit. The leaves may wilt before or after, becoming light yellow in color, or drop off before the close of the growing season. In case the infested plant dies during the dormant season the remaining characteristics must be relied on for identification.

2. The roots and crowns of plants should be carefully examined for the presence of rhizomorphs. They are about the diameter of the lead in a common pencil, usually nearly round, branched, and may vary considerably in diameter within a length of a few inches. In many fields sorrel is very abundant. The roots of these plants, and especially the dead ones, may be mistaken for rhizomorphs. Rhizomorphs may be easily distinguished, however, if the following characteristics are noted. Roll them between the thumb and forefinger. The moist, round body is reduced to a very delicate thread. At the same time the outer dark colored covering is removed as many thin, brown flakes of variable size and shape. There will be a distinct mushroom odor on the fingers. This odor is perhaps the best means of recognizing the rhizomorphs. By pulling the rhizomorphs in sections and examining the broken ends very critically by holding the end near the eye and toward a strong light it will appear like a small tube, from the end of which

FIGURE 4—CANE OF RED RASPBERRY WITH VERY FEW RHIZOMORPHS ATTACHED TO IT, BUT WITH A LARGE GROUP OF TOADSTOOLS AT THE COLLAR

FIGURE 2—CROWN AND ROOTS OF RASPBERRY WITH NUMEROUS RHIZOMORPHS OF ARMILLARIA MELLEA ADHERING TO IT

A large number of the rhizomorphs were growing through the ground around the roots of the plant, some of which may be traced, passing across several branch roots. In all cases where rhizomarphs touched the root, strands from the rhizomorphs grew into them. The illustration also shows numerous strands on the base of the canes and on the main roots, which adhere closely to the wood for their entire length.

projects a mass of fine cottony threads. From this observation it is plainly seen that the rhizomorphs consist of very large numbers of threads of the mycelium, enclosed by a solid coat. While breaking the rhizomorphs into sections it will also be noted that they will slightly stretch before breaking. Roots of sorrel will break off squarely, and will usually snap.

Trace the rhizomorphs on the surface of the plant. At intervals they will disappear. Where the rhizomorphs disappear the mycelium enters and spreads out as a white, fan-shaped layer of delicate threads, which, when abundant, form a white sheet. The black, outer layer of threads has disappeared. This protective coat is not necessary, since the threads are now buried in and protected by the parts of the plant in which they grow. Of the means of identification, rhizomorphs are the best, since they are so characteristic and are most constant of the visible parts of the fungus.

3. As indicated by a large number of observations, the fruiting stage, or toadstool, is seldom formed. In case they do appear they are of considerable service in identifying the disease. They are honey-colored or light brown over the entire surface, including stem, cap and gills. They are about the same size as the common edible mushroom, and may be situated on any part of a root or the crown of a plant. They occur in groups of two or more, and frequently form large, dense clusters. There will be difficulty, in most cases, in finding specimens in which the relation of the toadstools, rhizomorphs and mycelium may be readily seen, since specimens may be taken showing all the parts intact—toadstools bearing a rhizomorph, the end of which terminates in a velvety-white, fan-shaped sheet, or a thin, fan-shaped layer of radiating threads embodied in the roots or crown of the plant, usually lying between the bark and the wood. The toadstools rarely occur until late in the fall, and then only persist for a few days, since they decay quickly. Decay is also hastened by the action of the fall rains. For this reason they are of less diagnostic value in the identification of the disease than the rhizomorphs, which are by far more constant and very seldom decay.

After a plant has become diseased there is no hope of curing it. It may live for a period of several years or may die in a single season. It is advisable to retain diseased fruit trees as long as they produce paying crops of fruit, unless they are a menace to neighboring trees. Since the rhizomorphs seldom occur more than eighteen inches below the surface of the soil the spread of the fungus through the soil may be prevented by digging a trench about two feet in depth around the tree near the ends of the roots. The dirt should be thrown inside the trench line. In removing a diseased or dead tree the trunk and enough of the main roots should be removed to collect all parts containing the fungus in order that the destruction will be as complete as possible.

Diseased plants, such as the bush or other small fruits, should be removed and burned at once. The plants are grown so close together, especially in the rows, that the fungus is readily carried to neighboring plants through cultivation or by the rhizomorphs growing from the roots of one plant into those of another with which they may be in contact; or by growing through the soil from one plant to another, which is not of rare occurrence. After the diseased plants have been removed and burned one should avoid resetting any kind of plant the fungus will attack. When this system has been practiced results have been discouraging. The fungus in the soil will also attack the new plants, and in time will kill them. The ground from which diseased plants have been taken must be utilized for a period of at least three years for growing crops which are not susceptible to the disease, such as grains, grasses and garden truck. There is no known method by which the fungus in the soil can be destroyed. In case toadstools form before the plants are destroyed these toadstools should be collected and burned at once. They produce countless numbers of spores. Each spore is capable of producing new infection. Trampling the toadstools into the ground, throwing them into the roadway or burying them is not a good practice. None of these methods destroy the spores. The toadstools must be collected and burned in order to accomplish the desired results. There is no doubt that the spores are the best means of scattering the fungus. There is good evidence that in many cases they are responsible for isolated groups of blackberry and raspberry plants becoming diseased.

Since the fungus frequently enters plants through wounds caused in cultivating care must be taken not to cut the roots by deep plowing. The greatest amount of root injury from cultivation is probably due to a lack of cultivation during one or more years, followed by deep cultivation to put the ground in good tilth in as short a time as possible. Such a system should not be practiced, since disastrous results are apt to follow. Practice a good system of cultivation, in order to keep the plants in a vigorous, healthy condition.

WHAT IRRIGATION IS DOING FOR UNCLE SAM'S

THE following story taken from the columns of the Journal of Commerce and Commercial Bulletin of New York City gives some facts and figures which, to the student of irrigation, present some phases that are entirely new, and also startling. The article also shows the Yakima irrigated lands are considered the most valuable of all watered lands:

"The future of irrigation is large with promise. Eleven million acres were under irrigation in the United States on January 1, 1908; since then the rate of progress has quickened, and a responsible government official now says that 'a conservative estimate is that 30,000,000 acres of land will be reclaimed in the arid West. On this basis there will be homes on the land for more than a million families. Each family on the farm will support another family in the urban communities which will rise on these new agricultural districts. Looking forward to 1950, when our population is likely to be 150,000,000, who can measure,' he asks, 'the importance of a work which will guarantee homes and employment for ten millions of people, and which will bring into cultivation such a vast food producing area? National reclamation gave a wonderful impetus to private enterprise, and astonishing success in the settlement of large areas has followed the efforts of a number of corporations working in conjunction with state governments. There is more activity on the part of individuals in irrigation work today than in any previous time in our history.'

"The need for wider and more scientifically directed agricultural activity was never greater than it is today, when foodstuffs have risen to prices that mean hardships for many thousands, not to say millions, of our population. Irrigation not only turns virgin deserts into fruitful fields, but it makes possible that intensive cultivation which has been so wantonly neglected, though sorely needed in this country. President W. C. Brown of the New York Central Railroad system, recently pleading for better farming, said: 'Given the same methods of seed selection, fertilization and cultivation, our lands will produce as large crops as those of any other nation. A simple comparison of the average yield per acre of the principal cereals in this country with those of the older nations is the severest possible criticism of our methods, or our want of method. During the last ten years our farms have produced an average yield of wheat of less than 14 bushels per acre. England produces more than 32, Germany about 28, the Netherlands more than 34 and France approximately 20. Of oats the United States produces an average annual yield of 23.7 bushels per acre, England 42, Germany 46 and the Netherlands 53 bushels. Potatoes, like wheat, corn and bread, are also a staple of the poor man. Our average yield is 85 bushels per acre, while Germany, Belgium and Great Britain produce 250 bushels.'

"Irrigation can aid in rectifying all this. For what is irrigation, as now being discussed? It has been aptly described by a well known banking firm engaged in this business as 'the application of moisture to land by artificial means, for the purpose of fertilizing land and stimulating the growth of crops thereon. It may be briefly explained as the permanent diversion of water from rivers, lakes and other sources of supply, and its subsequent conveyance over 19829 Bet Frt Morath 3-17-11 Gal 44 tracts of land, by means of canals and ditches of gradually diminishing size, until through miniature ditches or furrows—perhaps but a foot or two apart—it serves to fertilize the soil with which it is brought in contact. The ideal engineering condition in irrigation projects

involve, initially, a natural lake, at an altitude considerably above that of the lands to be irrigated or a river whose flow is dependable, and whose fall and that of the land is sufficient to permit of the conveyance of the diverted water through canals, by gravity, over the entire contemplated area, together with natural reservoir sites, for the storage of water to supplement the river's flow in times of unusual drouth, and as a safeguard against any contingency which might arise. The diversion from the river may be accomplished by means of dams, those of more recent construction being of rock and concrete, raising the river to a proper height, and provided with numerous gates for the proper regulation of the flow. The main canals, to be of permanency, are constructed of rock, earth and concrete, leading off from the main canals to the ditches, which carry the supply to the individual farms, upon which the flow is regulated by means of frequent headgates, permitting thereby the water to course through the furrows made by the farmer according to his needs, or enabling him to irrigate his land by flooding it. The process of irrigation by no means contemplates a continuous flow of water, but involves a thorough moistening of the soil, perhaps but three or four times during the growing season, according to the character of the crops, and then requiring the water to be 'turned on,' but for twelve or twenty-four hours at a time.'

"The proper application of the irrigation thus lucidly described can turn desert soil into fertile fields or orchards worth several hundred dollars, occasionally more than a thousand dollars per acre. The following table, compiled from the detailed records of the United States Reclamation Service, shows where the principal projects are located and a conservatively estimated value of the land per acre when brought under irrigation; it should be explained that in almost every instance this land would be worthless if left devoid of an artificial water supply:

State and Project	*Value per Acre*
Arizona—Salt River	$100 to $750
Arizona-California—Yuma	100 to 500
California—Orland	100 to 250
Colorado—Grand Valley	100 to 250
Colorado—Uncompahgre Valley	75 to 500
Idaho—Minidoka	40 to 100
Idaho—Payette-Boise	100 to 500
Kansas—Garden City	100
Montana—Huntley	100 to 250
Montana—Milk River	75
Montana—Sun River	75
Montana-N. Dak.—Lower Yellowstone	75
Nebraska-Wyoming—North Platte	150 to 250
Nevada—Truckee-Carson	100
New Mexico—Carlsbad	100 to 500
New Mexico—Hondo	75 to 500
New Mexico-Texas—Rio Grande	75 to 300
North Dakota—Pumping	50 to 150
Oregon—Umatilla	100 to 200
Oregon-California—Klamath	100 to 200
South Dakota—Belle Fourche	75 to 150
Utah—Strawberry Valley	50 to 250
Washington—Okanogan	700 to 1500
Washington—Yakima	500 to 2500
Wyoming—Shoshone	150

"The present administration is scarcely less enthusiastic than its predecessor in carrying on the great work of reclaiming parched, useless territory and fitting it to draw thousands of city dwellers from their overcrowed, unhealthy haunts to the bracing virile mountains and plains, thus helping to solve one of the gravest social problems of the day. The government's projects now on hand are computed to cost a total of $119,550,000, of which $47,948,046 had been spent to November 1 last; 3,037,961 acres are to be irrigated, 722,275 having already been completed, while the estimated value of the land when irrigated is put at $239,435,600, as is shown in the statistical summary (obtained from the Department of the Interior) accompanying this article. In connection with this work there had been built up to June 30 last—and the figures have been subsequently increased since—417 miles of roads, 4,215 miles of canals, 90,388 feet of tunnels, 353,404 linear feet of dykes and levees, 975 bridges of a total length of 25,668 feet and 1,127 miles of telephone lines, while 59,431,463 cubic yards had been excavated, 915,751 barrels of cement utilized and 765,487 yards of concrete used.

"President Taft, in speaking of this work and the financial aspect of it, said: 'No one can visit the Western country without being overwhelmingly convinced of the urgent necessity for the proper treatment of arid and semi-arid lands by the extension system of irrigation. The results in the productivity of the soil when irrigated are marvelous. The mere fact that the reclamation service has gone ahead too fast ought not to prevent Congress from lending its aid to overcome the difficulty. We shall know better in the future use of the $50,000,000 how to avoid putting ourselves in a similar position again."

SUMMARY OF NET COST, IRRIGABLE AREA, AND VALUE OF LAND WHEN IRRIGATED OF THE VARIOUS GOVERNMENT RECLAMATION PROJECTS

State and Project	*Net cost to Oct. 31, 1909*	*Irrigable area of land in project: Total acreage to be irrigated*	*Irrigable area of land in project: Acreage now under irrigation*	*Acreage charge for water right*	*Estimated value of land when irrigated*
Arizona—Salt River	$7,613,219	240,000	131,000	(*)	$16,400,000
Arizona-California—Yuma	3,497,686	90,100	7,000	(*)	9,000,000
California—Orland	227,728	14,000	.....	(*)	1,400,000
Colorado—Grand Valley	59,794	53,000	.....	(*)	5,300,000
Colorado—Uncompahgre	3,783,917	140,000	20,000	(*)	14,000,000
Idaho—Minidoka	2,574,492	132,031	82,018	$22.00	7,000,000
Idaho—Payette-Boise	2,576,199	348,000	60,000	30.00	15,800,000
Kansas—Garden City	375,059	10,677	10,661	37.50	1,000,000
Montana—Huntley	905,558	28,921	28,921	30.00	2,169,075
Montana—Sun River	538,223	276,000	14,811	30.00	16,115,000
Montana—Milk River	329,903	215,000	.....	(*)	21,000,000
Montana-N'th Dakota—Lower Yellowstone	2,752,753	64,621	43,348	42.50	4,846,650
Nebraska-Wyoming—North Platte	4,236,092	124,000	68,960	35.45	12,400,000
Nebraska-Wyoming—Goshen Hole	.....	100,000	.....	(*)	10,000,000
Nevada—Truckee-Carson	4,004,210	200,000	81,361	22.00 / 30.00 / 35.00	20,000,000
New Mexico—Carlsbad	678,368	20,073	20,073	31.00	1,505,475
New Mexico—Hondo	343,117	10,000	2,000	(*)	750,000
New Mexico—Leasburg	188,326	20,000	20,000	(*)	.....
New Mexico-Texas—Rio Grande	226,115	180,000	.....	(*)	15,500,000
North Dakota—N. D. Pumping	791,115	23,171	12,097	38.00	1,158,550
Oregon—Umatilla	1,138,425	20,440	11,215	60.00	2,000,000
Oregon-California—Klamath	1,781,987	172,000	30,829	30.00	8,600,000
South Dakota—Belle Fourche	2,165,950	101,967	12,023	30.00	5,098,350
Utah—Strawberry Valley	794,598	60,000	.....	(*)	6,000,000
Washington—Okanogan	518,829	10,000	2,122	65.00	1,000,000
Washington—Yakima (Sunnyside unit). / Washington—Yakima (Tieton unit)..... / Washington—Yakima (Wapato unit)....	2,701,957	100,000 / 36,000 / 116,000	17,701	52.00	31,500,000
Wyoming—Shoshone	3,144,424	131,900	46,135	45.46	9,892,500
Totals, December 8, 1909	$47,948,046	3,037,961	722,275		$239,435,600

(*) Charges not yet fixed by the Secretary of the Interior.

HOW TO IRRIGATE BY THE PUMPING SYSTEM

BY R. A. JONES, SPOKANE, WASHINGTON

IT SEEMS strange that a fruit grower should undertake to write a paper on an engineering subject. In explanation of this I will say that previous to my engagement in fruit growing I followed the profession of a civil engineer and was mostly engaged in hydraulic and steam work, therefore I venture to write on this subject.

It is difficult to write an article on the subject that can be read and discussed within the short space of time allotted to each paper and do justice to it.

There is no one particular kind of pump or power that can be considered as best for all cases. For low and medium high lifts the centrifugal style of pump is probably the best. A comparatively new style called the turbine pump is better adapted to high lifts than the centrifugal and for extremely high lifts the piston or plunger pattern gives the highest efficiency. In general I would not advise the use of the centrifugal pumps for heads greater than 150 feet, and 100 feet would probably be a better limit. The centrifugal pumps have in their favor low first cost, very little or no repair expenses, very simple and not liable to get out of order. In fact they are so simple that it scarcely requires any brains to keep them in order. The greatest objection to them is the low efficiency which can be obtained. This will vary according to the height to which water is raised, and range from forty to seventy per cent. The greater the height the less the efficiency.

Of the piston or plunger type of pumps the outside center packed plunger pattern is the best, but they are also the most expensive, but can be depended upon to give the highest efficiency, generally about ninety per cent. Direct acting or duplex steam pumps are simple and low in first cost, but very wasteful in the use of steam.

First, and the best motive power for pumps, water power by turbine water wheels.

Second, electricity where it can be obtained. But in general it will be necessary to use some other power.

Third, an automatic engine of the compound condensing or triple expansion type. But the great objection to this kind of power is the first cost of

the machine and, too, that it requires skilled engineers to operate them. Such a power as this is more suitable to large plants than to small ones, and I could scarcely recommend such an engine to anyone who intends to irrigate not more than forty or fifty acres. In many cases the gasoline engine would be the best sort of power to use. Producer gas engines are being used to a considerable extent for pumping and other power purposes, and appear to be giving good satisfaction and are economical in the consumption of fuel.

It is claimed by the builders, and some of the users, that they are the most economical form of power (where fuel of any sort is required). I have been unable to get any data on the performance of producer gas engines that would be of any great value to intending purchasers of power plants. The last kind of power which I will consider is the current wheel or current motor. So far I have never seen or do not know of any device in the form of a current motor that is of any value for irrigation on a large scale. They may be all right to furnish water to a house or barn, or small tract of land, but beyond this they are worthless.

In making these remarks on the current motor I do not want it understood that I am making light of the many devices of this sort for producing power. On the other hand, I admire the genious of the inventors, and believe that some of them have achieved as good results and as practical as possible. The point on which they all fall down lies in the fact that the theoretical power of the current which is utilized by the motor is generally very small. Now, it is plain that it is a physical impossibility to obtain any more than the actual theoretical power. I have often heard inventors of current motors claim for certain specified locations that twenty, thirty or forty horse-power naturally existed in those places, but when an accurate measurement was made the actual theoretical power would fall down to two, four or six horse-power, as the case might be. And of this theoretical power it is safe to say that not more than from forty to fifty per cent efficiency can be obtained with the best current motors. This will give in practice only from one to three horse-power, which is rather small for pumping purposes in most places.

Wherever the currents or rapids of a stream show any considerable amount of power then the best way to utilize it and get the greatest efficiency is by the use of the turbine water wheel.

Referring back to the steam engine as a power for pumping I want to say that the most economical engines in point of fuel consumption are not always the ones most advisable to buy. If it is for a plant of considerable power, say from fifty horse-power up, then it may be advisable to use the best automatic engines that can be obtained if the price of fuel is considered. On the other hand, for small plants of ten, fifteen or twenty horse-power the plain slide valve engine will generally be advisable.

Some builders of automatic engines claim to reduce the consumption of fuel to less than half that required by plain slide valve engines. The comparative steam consumption of these engines has been shown by many tests to be about as follows: A good slide valve engine, well proportioned to its load, will develop a horse-power on forty-five pounds of water per hour; a good Corliss automatic engine will develop the same amount of power with about twenty-five pounds of water per hour. In both cases this is for simple non-condensing engines. With the compound or triple expansion engines of very large size the amount is then reduced to approximately ten pounds of water per horse-power per hour. But such a plant as this would be quite out of the question for the ordinary sized piece of land, which will generally range from ten to forty acres.

To get the amount of fuel required for a horse-power we find, in practice, that about the best result obtainable is the evaporation or conversion into steam of ten pounds of water per pound of first class coal. This would give for the finest constructed plants one horse-power per pound of coal per hour, and for the plain, common engine one horse-power for four and one-half pounds of coal. But in common practice these results are not always obtained, and I personally know from experience that double these amounts of fuel are used. Fine tests, showing great economy, is one thing and the results of common practice is quite another.

The amount of gasoline required to produce a commercial horse-power is generally estimated at one pint per hour per horse-power. I have known of cases where they claim to produce a horse-power with half the amount, but in general I do not think it is safe to rely upon such a small quantity.

At one time I was working nine steam engines, ranging from ten to one hundred horse-power, and the cost of fuel was an important matter. I found by a practical test that a cord of dry fir or tamarack wood would do as much work as a ton of Rock Springs coal.

The limit of elevation which it is practical to lift water by pumping for irrigation depends almost entirely upon the value of the crops produced. High priced and very valuable crops will stand the cost of pumping to elevations as high as 300 to 400 feet. At my own place, near Spokane, I pump to an elevation of about 200 feet with steam power and irrigate about forty acres. We use a 7x10-inch twelve horse-power slide valve engine, connected by a belt to a Gould triplex plunger pump, and a thirty horse-power boiler, and it requires about two cords of fir or tamarack wood per acre per year. This is for about eighty days' irrigating season, and using about three-fourths of an acre foot of water. These results are not economical, but our wood costs only the cutting.

The amount of water required per acre varies greatly in different localities for different crops and different age trees. The climatic conditions alone will affect the amount of water required to a large extent. An old orchard will require several times as much water as a very young one. Sandy soils need very much more water than fine, compact soils.

It will be seen from the above forms of power for irrigation and from local conditions that no definite or exact amount of fuel or cost per acre can be given that will cover all cases, but careful consideration and examination by some competent engineer should be made for each particular location.

At this point it may be well to say that in many of the United States government calculations the engineers allow one cubic foot per second per 160 acres, which is equal to one acre foot in about eighty days. An acre foot is the amount of water required to cover an acre of land one foot deep. In some cases this amount is more than is necessary, while in others it is entirely inadequate.

The first thing to be considered in a pumping project is the amount of water needed and the next is the amount of power required; third, the kind of power best adapted to the location, which can be determined as follows: First, water power by turbine wheels; second, if you are near an electric line then electric power would be the next choice; third, if you are in a locality where wood or coal is plentiful and cheap then a steam engine would probably be the best, especially if you are in a locality where gasoline is expensive; fourth, if at a considerable distance from a railroad and not under any of the above conditions then a gasoline engine would be advisable; fifth, if near a lignite mine or in a locality where lignite or other suitable fuel can be obtained at a reasonable price then I would say investigate carefully the producer gas engine.

In estimating the amount of power necessary for pumping three factors must always be considered, as follows:

Time, number of cubic feet of water and the height it is to be raised. The application of these three factors give only the theoretical power, and it is the common practice to double the theoretical power to overcome friction, leakage and other imperfections. The size of delivery pipe is often responsible for waste of power. It should be borne in mind that by doubling the diameter of a pipe increases its carrying capacity nearly five times, yet it does not generally cost more than twice as much. It may also be well to mention that the amount of power required to pump any given quantity of water (other things being equal) is directly in proportion to the height at which it is to be delivered. For example, if it requires ten horse-power to pump a certain quantity of water to an elevation of 100 feet it will require twenty horse-power to pump the same quantity two hundred feet high.

Reducing to its simplest form the contents of this paper we may deduce the following, from which conclusions can be drawn as to the best means of power and pumping by taking into consideration local conditions: First, the water power by turbine wheels is first choice; second, that electric power, when it can

be obtained reasonably, is second choice; third, that a cord of seasoned fir or tamarack wood is about equal in fuel value to a ton of Rock Springs coal; fourth, that is requires about one pint of gasoline per horse-power per hour in gasoline engines, or distillate, is probably about thirty per cent cheaper; fifth, that it requires, as shown by scientific tests, at least one pound of coal per horse-power per hour for the best steam engines obtainable, and about four and one-half pounds per horse-power per hour for common engines, and I would add at least fifty per cent to these amounts of coal to make good in practice; sixth, that centrifugal pumps are not recommended for lifts much over 100 feet; seventh, that where centrifugal pumps are used more power must be provided to do the same work as with plunger pumps; eighth, that large pumping plants are proportionately more economical than small ones; ninth, that it requires 1.71 theoretical horse-power to raise sufficient water 100 feet high (and other elevations in proportion) to cover ten acres one foot deep in eighty days, and this theoretical power should be doubled to give satisfactory results in practice, or about three and one-half horse-power; tenth, the cost of attendance and incidentals must be considered, bearing in mind that turbine water wheels and electric motors need but little attention.

ORIGIN AND RESULTS OF DEMONSTATION TRAIN

BY PROFESSOR W. T. CLARKE, UNIVERSITY OF CALIFORNIA

THE Special Agricultural and Horticultural Demonstration Train now being operated in California by the Southern Pacific Company, and co-operated in by the College of Agriculture of the University of California, is by far the most extensive effort of this kind that has ever been put forth in any part of the country. As such is the case, a few words of explanation as to the inception, meaning and the value of this train are in order.

The spirit of the great transportation companies of today is to recognize the fact that the success of the producers along its lines means the greater success of these companies. A spirit of co-operation with the producers is manifested, and the Southern Pacific Company, recognizing the fact that better results should be obtained from the farms of the state, and also recognizing the fact that its best interests are bound up in the success of the producers, has joined with the College of Agriculture and Experiment Station of the state in bringing to the farms and to the workers thereof improved methods of procedure, whereby better returns could be obtained. The inception of the idea of the Demonstration Train, then, is to be found in the recognition of the interdependence of the producers and the transportation company, and, further, the recognition of the fact that the College of Agriculture and Experiment Station has much of value to illustrate and show the men and women of the farms.

The first train to be sent out in this co-operative endeavor began its work on November 9, 1908, covering, in the eight days that it was out, the northern and southern portions of California. The train consisted of two carloads of exhibits illustrating better methods of agricultural and horticultural practice, and also methods of control of insect pests and diseases of trees against which the producer had to contend. A total of six runs was made in the season of 1908-9, and all of the Southern Pacific lines in California, with but few exceptions, were covered by the train service. A total of 37,270 people visited the train on these runs, and a great deal of interest was manifested by these visitors.

The season for 1909-10 began on the 16th of November, 1909, and covered much of the same territory as was covered in the season of 1908-9. During this season the train was in service a total of sixty-eight days and made 223 stops. A total of 73,663 people visited the train. In this connection it is interesting to note that during the season of 1908-9 twenty-six such trains were run in the United States. A total of 182,745 people visited these trains. The California total is included in these figures. It then follows that forty per cent of the people visiting demonstration trains in the United States were those who visited and obtained information and inspiration from the California train. This is a record to be proud of, and surely indicates the appreciation in which this work is held.

The season for 1910-11 began on the 5th of December, 1910, and on the first run of ten days the same territory was covered that the train visited in its first run last year. Visitors to the number of 14,217 came to the train on this run, an increase of sixty-seven per cent over the number for the same run last year. This again speaks well for the value of the Demonstration Train.

Six cars are at the present time devoted to the purposes of demonstration and illustration. The material carried in these cars illustrates better methods of procedure in all lines of agricultural and horticultural practice and demonstrates the great value of improved methods of work experimented with and advocated by the Experiment Station of the University of California. The train, with its well equipped departments and its living cars for the use of the experts accompanying the train, may be considered, and indeed is a university on wheels, carrying to the tillers of the soil the gospel of better horticulture and better agriculture, and indicating by concrete examples methods through which much better returns may be obtained on the farm.

The meaning, then, of this train service is to be found in the expression, "education of the producer carried along more scientific lines of work." The value of the train service can hardly be overestimated. Many earnest people who visited the train during its 1908-10 runs have re-visited it this season, and have spoken enthusiastically of the good the work had done them. There is much evidence on hand to show that methods of practice illustrated and described during the last year's runs have been put into use in the meantime, and are producing satisfactory results. An immense amount of correspondence has come in regarding the work already done, indicating that the writers of the letters received, were thinking of, studying and searching for further information along the lines touched upon in the train.

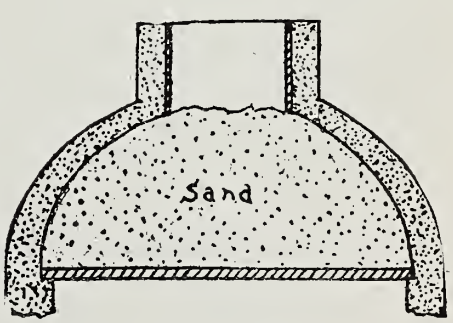
The bringing of the work of the College of Agriculture so directly to the producers of the state is to be credited to the enlightened action of the transportation company. The expense of maintaining a moving train of this character is far too great for any educational institution to undertake, and the recognition of the value of this work and the very tangible illustration of this recognition by the transportation company is an idea well worthy of consideration by all thoughtful people. The Special Agricultural and Horticultural Demonstration Train, operated under the joint auspices of the University of California and the Southern Pacific Company, is unquestionably the greatest as well as the most far-reaching educational and value-improving factor ever set in motion in this State of California.

◈ ◈ ◈

TO BUILD A CONCRETE ARCH. Where it is desired to arch over a well or cistern, or any other structure, the following method will be found of practical use:

After the wall is to the point where the arch is to begin, or the skewbacks, lay a temporary platform of boards on the wall with the edges resting on same just enough to hold, and no more; upon this pile up sand into the form the arch is to be made, and within about eighteen inches of the top of the ground; upon this sand set a box form to mold the manhole to the well.

Now plaster the concrete around the



sand and box form in the manner shown in illustration; for all ordinary work it should be from three and one-half inches to five inches thick, depending on the diameter of the well or cistern.

As soon as the concrete has hardened take out the sand with shovel, then the temporary platform may be removed and the work plastered on the inside. —Iowa Homestead.

BETTER FRUIT

HOOD RIVER, OREGON

OFFICIAL ORGAN OF
THE NORTHWEST FRUIT GROWERS' ASSOCIATION
A MONTHLY ILLUSTRATED MAGAZINE
PUBLISHED IN THE INTEREST OF MODERN
FRUIT GROWING AND MARKETING
ALL COMMUNICATIONS SHOULD BE ADDRESSED AND
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THE editorial space of "Better Fruit" is always considered one of our strong features. There are several broad and important problems before the fruit growers of the Northwest today which are entitled to editorial space, but instead of discussing them editorially it seems wisest to publish the contributed articles which have been sent in, for the reason that these contributed articles cover the subjects more forcefully and more thoroughly than they might be covered by the editor of "Better Fruit." Therefore, we call the attention of the readers to the following articles, in lieu of editorials, which appear elsewhere in this edition:

"The Central Selling Agency for the Northwest Fruits," so ably handled by H. O. Stechhan, who has been in close touch with H. W. Otis, chairman of the executive committee appointed at Walla Walla conference in February. Elsewhere in this edition will also be found the general plan for central exchange as adopted by Walla Walla delegates. The editor of "Better Fruit," having just returned from California, being detained by illness, was unable to attend this meeting. It is understood that this general plan will be presented to the individual districts for approval or correction, and will again be presented at a meeting of these delegates at some place in the near future. So far the place has not been designated nor the date set, but it is understood that another meeting of delegates will be called, of which due notice will be given, some time in April. Especial attention is called to the "Resolutions and Rules Applying to Storage in Transit of Apples," adopted by a conference composed of delegates of the Western Fruit Jobbers' Association, the National League of Commission Merchants and the National Apple Shippers' Association. Another article touching this matter is a set of resolutions, which appears in this edition, adopted by a committee of the Central Selling Agency of the Northwest fruits. On this same subject we publish an article entitled, "Storage in Transit," being a review of the situation, which appeared in the "Spy," a journal published in the interests of the National Apple Shippers' Association.

After careful perusal of all these articles they must be conceded to be of vital importance to the fruit growers of the Northwest. Each and every one of these articles, by men thoroughly familiar with the situation, handle the respective subjects in such an able manner that it leaves but little for editorial comment, and they are published in this issue complete, without any alterations.

The editor, having been in California for some time, and his time having been taken up on other matters that could not be postponed, feels that he is insufficiently informed on the subjects treated to warrant further editorial elucidation.

CENTRAL SELLING AGENCY *for* NORTHWEST FRUITS

BY H. O. STECHHAN

NO movement among any body of men engaged in soil culture ever undertaken heretofore promises to have such far-reaching beneficial effects all around as the projected organization of the fruit growers of Washington, Oregon, Idaho and Montana for the handling of their crops through one central selling agency. No improper methods of control are contemplated which might be construed to operate in restraint of trade. The whole purpose is to create a system of distribution that will eliminate disastrous competition among those whose interests are identical, thereby putting the horticultural industry of the Northwest on a sound business basis, in accordance with its just deserts.

The present value of the crop to be handled has been estimated at $10,000,000, but there is no definite information on the subject. That brings up another imperative need for this organization, viz., the gathering of information concerning the fruit growing industry so that it will be available for all persons connected with the business, to be used by them intelligently, just like the lumbermen, the cotton interests and wool growers have been able to advance their prosperity through similar co-operative efforts.

Without doubt most fruit growers in the Northwest today have been making a profit, but when it is taken into consideration that a steadily increasing acreage will begin to yield marketable stuff in the next five and ten years the necessity for some means of distributing intelligently the increasing output will be seen. To this end it is essential that the producer be made independent of the middleman, who controls the situation now, frequently to the disadvantage of the grower, the dealer and the consumer as well.

At the conference of Northwest fruit growers recently held in Walla Walla, following the preliminary meeting in Portland, a tentative form of organization was agreed upon, which follows the suggestions made some years ago by Secretary of Agriculture James Wilson. An executive committee was named, consisting of representatives of all the fruit districts in the Northwest. After thrashing out the scheme each one was instructed to take it up with the home association of growers and to report back at a subsequent meeting which is to be held in April. H. W. Otis, of Wenatchee, was made chairman of the executive committee. In advocating the central selling agency as offering relief to all fruit growers Mr. Otis emphasizes the fact that the plan is not a hastily formed scheme, but the result of carefully studying conditions that have confronted all agriculturists for years. As one of the foremost growers of the Wenatchee Valley, where he has brought a large orchard into bearing, Mr. Otis speaks with authority.

In the accompanying authorized interview Mr. Otis seeks to put before the readers of "Better Fruit" compactly just what the organization is and intends to do. He says:

"No outside promoters or influences have any part in the attempt to line up the fruit growers of the Northwest to put the orchard industry on a sound basis. By this movement the growers merely wish the privilege of handling direct that which they are producing instead of taking the blind chances of delegating the distribution to produce speculators. The plan of organization adopted at Walla Walla is the outgrowth of definite conditions confronting the growers in the Northwest. It is true that the most of them have been making money up to date, but in the face of a steadily increasing output every year it becomes necessary to take steps to develop new markets systematically to insure consumption of the large crops that will be raised on their increasing acreage in the next five and ten years.

"The entire lack of co-operation on the part of orchard men in the various districts, in the face of identical interests, the total absence of intelligent or systematic distribution, with the attendant evils of disastrous competition among the districts, have made the markets undependable and fluctuating. The result has been invariably the source of loss to the dealer as well as the grower. As a remedy it is proposed that district associations shall be formed, as already exist

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Continued from page 48

in some of the fruit sections, to control all of the details of growing and assembling the crops.

"These associations will form the nucleus of the central selling agency or exchange, which will have charge of the marketing. It will be properly located and equipped to handle the big business in an up-to-date way, employing the best sales manager and traffic expert that can be had for money. An executive committee representing each district will constitute the governing board. None of the districts will have to lose their individuality, as that feature will, in many cases, be an important aid in selling the crop. An educative publicity campaign will be carried on, like that of the California orange growers, to enlarge the demand for Northwest fruits.

"It is definitely stated and distinctly understood that the new organization shall not operate in restraint of trade. It will seek to advance the best interests of the grower and consumer, thereby incidentally benefitting the legitimate dealer in the long run by doing away with much of the speculative uncertainty that now accompanies the handling of fruits and produce. By eliminating the middleman in the selling of fruits direct from the grower to the dealer there will be a tendency to bring relief to the consumer by reducing the cost to him. Such an effect should be generously welcomed.

"The members of the executive committee named at the Walla Walla conference to put this plan into execution are now busy in their respective districts, acquainting the growers with the various details and adjusting any differences that may arise. A meeting will be called early next month, at which time the committeemen will report back their results. From advices received I have no doubt that we will be able to begin operations this year. All of the districts may not come in, but if it is found desirable to organize local associations, as many of the districts have done, without all the growers co-operating in the work, it strikes me that it will be just as well to launch this movement if only a limited number of districts decide to come in. There may be some difficulties, but they will not prove insurmountable, and before long, I am sure, we will be able to line up the solid Northwest."

Mr. Otis says that there is a woeful lack of knowledge as to the exact status of the fruit industry in the Northwest. The government compiles some statistics that are good as far as they go, but they have proved entirely inadequate. One of the first things this organization will undertake is to find out just where the fruit industry is "at," the same as the timbermen, cattlemen and wool growers have done. "There has been too much guess work," says Mr. Otis. "The time has come when we must introduce a system based on accurate knowledge of conditions.

"Because of the largeness of the problem many of the districts have hesitated to enter any scheme for organizing the whole Northwest. They have drifted along, letting the situation handle them instead of trying to handle the situation. There is nothing too big for an intelligent organization—one that is right and honest. This one is. The fruit growers simply want to take care of their best interests and get what they are entitled to for their labors. To be sure of this in the future it is necessary that they take action now."

The executive committee named at the Walla Walla convention is composed of the following well known fruit growers, representing all parts of the Northwest: H. W. Otis, Wenatchee, chairman; Sherwood Williams, La Grande, secretary; C. E. Whisler, Medford; J. F. Forvis, Dilley, Oregon; C. H. Sproat, Hood River; Miles Cannon, Weiser, Idaho; W. B. Lanahan, Clarkston; William Teadt, Hamilton, Montana; J. E. Trimble, Garfield; H. D. Lamb, Milton, Oregon; W. L. Nelson, North Yakima. These men will meet again on the call of Chairman Otis at a place to be designated. The Walla Walla conference was preceded by a preliminary meeting in Portland last January.

ORGANIZATION OF A CENTRAL FRUIT EXCHANGE

AFTER being in session several days the delegates to the Central Fruit Exchange took decisive action at Walla Walla by the adoption of a selling agency for the entire Northwest. In pursuing this course it is believed that fruit men have taken a step that will either be the most beneficial the fruit industry has ever known or it will cost them heavily for a year or so, and give them much valuable experience.

The main rules governing the establishment of the Central Exchange, the district agencies that compose it and the growers' organizations that compose the district associations are:

The Central Exchange will have the exclusive selling of all the fruit or products controlled by the district association holding a membership in the central. It will establish a sales system covering all markets where it is practical to sell the products of its members. It will establish such rules and regulations as are necessary for the proper caring for and marketing of said products, also such rules as are necessary for the maintaining of uniform grades and packs, and for the placing of the products of its members on the market in the best and most salable condition. It will maintain an efficient system of market and crop reports. It will do such advertising as is found necessary. It will strive to eliminate all unnecessary intermediate expense wherever possible. The Central Exchange will be maintained by a selling charge of not to exceed ten cents a box for apples, and on other products in proportion to the cost. The name, Central Exchange, and such trade mark or brands as it may establish shall appear in a prominent place on each package. The products of each district shall be marketed on their own merits. Each district shall be given its proportionate share of all markets.

The district associations will have control over the grading and packing of the products of its members. They will employ a sufficient number of inspectors to supervise grading, packing and loading. The operating expenses of the district associations will be met by a commission charge on all products and supplies handled. All profits derived from charges made to members for the handling of their products and supplies in excess of the maximum amount decided upon for the surplus fund, and all moneys received from Central Exchange in the form of profits from handling products shall be distributed annually among the members in proportion to the products handled for them. The membership of the district association shall consist of growers' organizations. The affairs of the district association shall be managed by an executive committee of five trustees.

The growers' organization shall have full charge of handling and preparing the

products for market. It shall employ and have control over all help needed. It shall provide warehouses, packing houses or loading platforms necesssary for handling products. All products for shipment are to be turned over to the district association when properly loaded on board cars or other means of transportation to market, as may be specified. It may own and operate carriers, by-product factories of all kinds, cold storage and pre-cooling plants. Growers' organizations shall make a loading or handling charge of a sufficient amount per package on all products or supplies handled to meet the expenses of the organization.

The grower shall, when called upon to do so by the Central Exchange, enter into a binding contract, appointing the Central Exchange his exclusive selling agent for all of his products of the kinds and varieties handled by the exchange, except as otherwise provided for in the contract. The contract shall be for a period of three years; provided, however, that any member may withdraw March 1 of any year by giving fifteen days' previous notice in writing.

Men named to perfect the exchange and the districts they represent are: H. W. Otis, chairman, Wenatchee district, Wenatchee; C. E. Whisler, Medford, Southern Oregon; J. F. Forvis, Dilley, Western Oregon; C. H. Sproat, Hood River, Central Oregon and Southern Washington; Sherwood Williams, La Grande, Eastern Oregon; Miles Cannon, Weiser, Idaho; W. B. Lanahan, Clarkston, Snake River; William Teadt, Hamilton, Montana; J. E. Trimble, Garfield, Inland Empire; H. D. Lamb, Milton, Oregon, Walla Walla district; W. L. Nelson, North Yakima, Yakima district.

The grading of apples has also been fixed by rules that cannot be mistaken. These grades are:

Extra fancy grade consists of perfect, well formed apples only, free from all insect pests and all defects. All varieties of apples admitted to this grade shall be well matured and of natural color characteristic of the variety; Spitzenberg, Winesap, Jonathan, Arkansas Black, Gano, Lawvor and other solid red varieties must have seventy-five per cent of good red color. Ben Davis, Rome Beauty, Baldwin, Wagener and other varieties of similar color must be fifty per cent red. Red Cheek Pippins and Winter Bananas must show a red cheek.

Standard grade must be free from all insect pests, worm holes, scale, sunscald, dry rot, water core or other defects; skin punctures or evidence of rough handling shall be considered as defects. Slight limb rub or one small sting healed over will be permitted, provided not over ten per cent of the apples in any box shall be so marked. All varieties of apples admitted to this grade shall be well matured and of natural color.

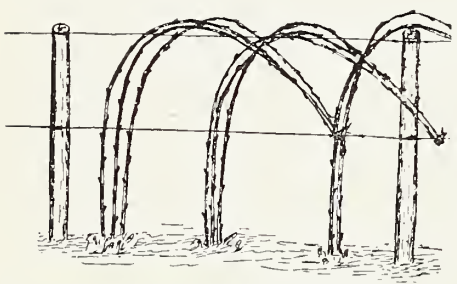
"C" grade shall be made up of all merchantable apples not included in the extra fancy or standard grades. These apples must be free from all insect pests, but will include misshapen apples or apples having a limb rub or other slight defects. Apples of this grade may also contain two worm stings or apples showing slight bruises. They need not be wrapped.

GROWING OF BLACKBERRIES AND RASPBERRIES

BY W. S. THORNBER, HORTICULTURIST WASHINGTON AGRICULTURAL EXPERIMENT STATION, PULLMAN, WASHINGTON

THE soil, temperature and general conditions of many parts of the State of Washington are admirably adapted to the commercial growing of practically all kinds of small fruit. This is particularly true of raspberries, blackberries and loganberries. Several localities west of the Cascade Mountains have already become famous as berry growing districts. Probably nowhere in the United States do these fruits grow to a higher degree of perfection than in these districts. With the opening up of large tracts of land for orchard purposes comes the demand for an early yielding, highly profitable crop that can be grown among the trees without danger of injuring them, and so for this reason large acreages of these plants are annually being planted in many parts of the state.

While raspberries and blackberries are more or less cosmopolitan as to their likes and dislikes of soil, yet they prefer a deep, rich, moist (but not wet), sandy loam, abundantly supplied with humus and nitrogen plant foods. However, they can be successfully grown on basaltic and volcanic ashy soils after humus has been added, provided there is sufficient moisture during the growing and fruiting season. Some of the soils of the irrigated sections of the state are not adapted to these fruits until one or more



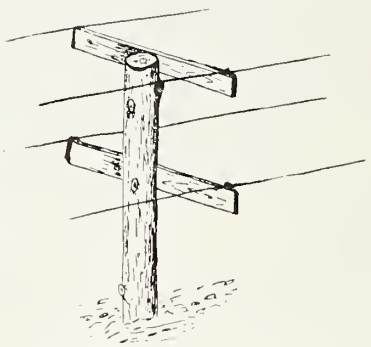
ONE WAY OF HANDLING TWELVE-FOOT CANES OF RED RASPBERRIES

crops of green manure have been plowed under.

One of the essential features of a good berry soil is thorough drainage, not only during the growing season, but also during the winter months. Soil that becomes saturated with water and so remains for even a short time is not adapted to berry culture, and should not be used until artificial drainage has been provided. Much trouble from root rot and root fungus can be avoided by providing good drainage. The factor of air drainage should also be considered in the making of a berry plantation. Good air drainage minimizes the danger of late spring frosts and materially lessens the injuries caused by some of our plant diseases.

Nothing can take the place of good, thorough tillage in the berry patch. A heavy mulch may keep down the weeds and hold the moisture, but it does not liberate plant food like cultivation. The spring cultivation should start as soon as the soil is dry enough to be worked, and should be deep enough to loosen up the soil, yet not so deep as to injure the feeding roots of the plants. The summer tillage should be shallow, but frequent, and continue regularly until the crop is safely harvested, and afterwards only frequent enough to maintain growth and keep the suckers and weeds down.

The perishable nature of berries make them one of the most difficult fruit crops



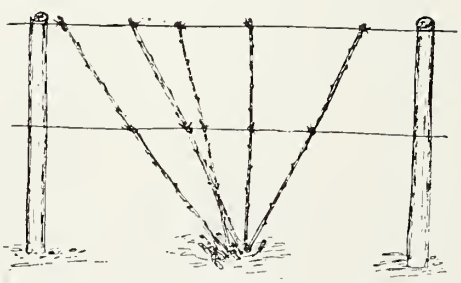
BEST FORM OF SUPPORT FOR WINE-PRODUCING SORTS OF GRAPES

to market that is commonly grown. However, if they are picked just as they are turning red, taken at once to the packing or cooling shed and handled with reasonable care they will be in their prime in from twelve to twenty-four hours. Berries picked in the morning ship better than those picked in the heat of the day, and under no circumstances should fruit be picked when the leaves of the plants are wet with dew or rain.

Where berries are not grown in sufficient quantities to warrant the use of refrigerator cars the Pony refrigerator should be used. Overripe fruit should be consigned to the cannery, and never be permitted to be sent to any distant markets.

The difference in the growth of varieties makes it necessary to use different plans to get the best results for all varieties.

For the convenience of this discussion I group all of these fruits into two classes, i. e.: "Upright growers," or such plants as produce erect canes, and "viny growers," or such plants as the Logan and Phenomenal berries, and Evergreen,



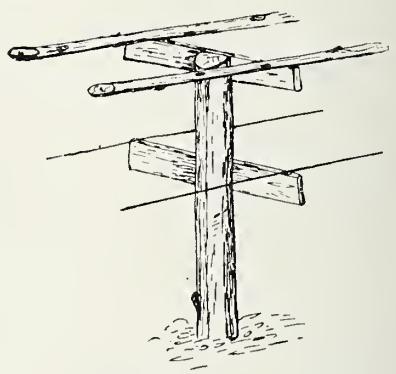
GOOD WAY TO SUPPORT THE CANES OF SMALL FRUITS IN WINDY LOCALITIES

Himalaya Giant and Early Mammoth blackberries, which produce long prostrate vines or canes.

The two general planting plans: "hill" and "continuous row" systems are about equally used in the commercial fields of the state. Each has advantages as well as disadvantages, and if not crowded either will give good results. The hill system affords the best opportunities for cultivation, air drainage, sunlight on all sides of the plants and ease of harvesting the crop, while the continuous row system permits the planting of more plants per acre without serious crowding.

The "upright growers" may be profitably planted according to either system, but "viny growers" must be grown in hills or they become a dense hedge, making satisfactory harvesting an impossibility.

The one common fault of practically all amateur fruit growers is the over-planting of their land. The fertility of the soil, annual rainfall or irrigation, and variety materially govern the distance apart plants should be planted. On the rich moist soils of Western Washington, where heavy growth is a certainty, or dry soils of Eastern Washington, where the conservation of the moisture must be practiced, the "upright growers" should be planted not closer than six feet apart each way in the hill system, or three by eight in the "continuous row" system. In irrigated sections, where moisture can be supplied at will, the plants may be



GOOD FRAMEWORK FOR SUPPORTING CANES OF RED RASPBERRIES

planted closer. However, it is not advisable, since what may be gained in additional number of crates per acre is frequently lost by the grade or quality of the fruit. On similar soils the "viny growers" should be planted in rows eight feet apart, and the plants from sixteen to twenty-four feet apart in the row, using the alternate system, and thereby affording a greater feeding area for the roots of each plant.

The "upright growers," where planted in hills, can best be staked by a single strong stake, from four to six feet in height, and the canes loosely, but very securely, fastened to the stake. Some growers prefer to set two stakes about fifteen inches apart at each hill of blackberries with the idea of training the fruiting canes on one and the growing canes on the other. Where the "upright growers" are planted in a continuous row they may be trained to and supported by a two-wire trellis, consisting of a single row of posts four to five feet high with a single No. 10 wire stapled to the top, and another from eighteen to twenty-four

inches from the top. The more common method, however, is to set a single line of posts four or five feet high in the row, nail an eighteen-inch cross-arm three feet from the ground and another at the top of the posts, and to the ends of these arms staple heavy wires, thus forming firm lateral supports for the canes.

The four-wire trellis, with the addition of notched cross pieces to lay on the lower wires, makes an excellent support for the "viny growers," the purpose being to suspend the growing canes by means of small cloth strings under the upper wires for the first year, and at pruning time lower them to rest on the notched pieces on the lower wires for their fruiting period. This makes an easy system to work and keeps the growing and fruiting canes separate, thereby simplifying the picking.

In sections where there is danger of winter injury the old fruiting canes should be left until spring, while in other sections they may be removed and the plant cleaned up immediately after they are through fruiting. The cutting back of the tops and final thinning of the canes should be done late in the winter or early in the spring, after all danger of winter injury is past. The "upright growers" should be cut back to sound wood from three to five feet in height, while the "viny growers" should be cut back to canes from six to twelve feet in length, depending upon their condition and strength.

The number of canes to be left per plant must be determined largely by the variety and the vigor of each plant. Strong upright plants will support from four to seven canes, while weak ones should not be expected to support more than two or three. Four canes per plant is the most satisfactory number for the "viny growers."

The following varieties have been thoroughly tested in the station gardens and found worthy or unworthy, as indicated in these brief notes:

Red Raspberries: Cuthbert—One of the oldest and most reliable, strong growing, midseason varieties, producing large crops of firm, medium sized, good shipping berries of fair quality. Its deep rooting habit makes it possible for it to withstand severe drouth as well as cold winters. Crimson Beauty—A strong, erect grower, producing large crops of medium sized, rather soft berries. Good for home use, but too soft for shipping. Improved Superlative—A very popular, strong growing variety with deep rooting habit, producing large crops of firm, dark crimson berries. Good for shipping as well as for home use. Marlboro—An old, well known variety adapted to Western Washington conditions, but too much subject to sunburn for Eastern Washington. A strong grower, heavy yielder and a good shipper of good quality. Philadelphia—A good early season variety that can be used for home use, but the fruit is too small and soft to be of value for commercial purposes. Red Antwerp—A well known standard commercial sort, producing large crops of dark red, fine quality, good shipping berries. Valuable for Western Washington, but rather tender for Eastern Washington. The plants are subject to root trouble, which makes great care necessary in the selection of new, clean stock. Ruby—An almost unknown new sort, which gives promise of soon becoming one of our best commercial sorts. The plants are strong, hardy and productive, while the fruit is large, of good quality and color and ships well. Turner—A good early, home-use berry, but too soft for commercial use. The plants are strong, productive and free from insect pests.

Yellow Raspberries: Caroline—A rank grower, good yielder and hardy plant, but the fruit is rather small and too soft to be of value. Golden Queen—A strong growing, hardy, old, well known yellow fruited sort, producing good crops of fine large berries. Not popular on account of their color.

Black Raspberries: Gregg—One of our best and most popular black sorts. Valuable for home as well as commercial growing. Kansas—An old, well known variety, but not adapted to our conditions. Valuable only as an early sort. Burkhart—A comparatively new, unknown sort, which promises to become very valuable for both home and commercial growing. Ohio—An old, well known sort, especially valuable for canning and evaporating purposes. While strong and vigorous, it is not generally productive in Washington.

Blackberries: Early Mammoth—An early, fine large, rich flavored berry, rather tender for general planting, but valuable where quality is desired. Evergreen—One of our hardiest, most productive and best all-around late blackberries. Valuable for commercial as well as home growing purposes. Himalaya Giant—A rather slightly known, productive, rank growing, viny sort. Valuable for commercial planting west of the Cascade Mountains, but too tender for general planting. Kittatinny—A very commonly planted sort, and while rather tender and subject to rust, yet produces very satisfactory crops. Snyder—One of our best and most popular early sorts. Valuable for commercial as well as home purposes. Stones Hardy—An old, well known, late variety. Valuable only where the more productive sorts will not stand the winters.

Loganberry—One of our newer fruits which is rapidly becoming popular on account of its productiveness, large fruit and fine quality. Grows well in all parts of the state, but requires light winter protection in Eastern Washington.

Phenomenal Berry—A fruit closely resembling the loganberry and profitably grown under the same conditions.

Lucretia Dewberry—A valuable but not well known recent addition to the blackberry family. While it is hardy, its trailing habit makes it possible to successfully grow this plant, by giving it winter protection, where the ordinary blackberry winter kills. Its early fruiting habit, productiveness and ability to thrive on many soils makes it popular as an orchard filler in many parts of the state.

FLUCTUATING CHARACTERISTICS OF THE APPLE

BY C. H. GOETZ, WASHINGTON AGRICULTURAL COLLEGE, PULLMAN

IN taking up the study of fluctuating characteristics in apples, the intention was to show in how far there was a fluctuation of characteristics in apples.

In the fall of the year, as the apples ripened in the orchard of the Washington State College, there was gathered from the trees of fifty different varieties of apples, enough fruit to make one hundred apples of each variety, for use in the investigation. These apples were taken promiscuously from the trees. They were stored in boxes in the cold storage, each box being marked with name and number.

During the winter the apples were cut up for investigation and study. One-half of them were cut lenghtwise for a study of the longitudinal outline form, for size, shape, form and size of tube, for shape of core line, depth, size and form of cavity and basin, for position of stamens and length of stem.

The other half of the apples were cut into cross sections for the study of the core lines or fiber vascular bundles, for size, shape and nature of cells, for cross-section outline, for position, form and nature of core.

These halves of the apples were as near as possible true halves. They were inked with indelible pencil on the face in such a way as to have them make clear cut and true impressions of the form and various characteristics of the apple as they were pressed upon paper.

Two impressions were made. The first impression was made on an absorbing paper, making a very strong impression. This was used for making a tracing of the apples. The second impression was made on a fine grained paper, to be used for further study. For further investigation photos or blue prints were made from the tracings.

The investigation of the fluctuating characteristics of apples brings out the following:

First. That there is a more or less fluctuation in certain characteristics, and that this is true more of certain varieties of apples than of others.

Second. That certain varieties of the apples show a tendency toward a constancy of characteristics, while others have a tendency to great fluctuation.

Perhaps the most fluctuating characteristic in all apples is found in the size, shape and appearance of the cells. Second to this comes the fluctuation in length of the stem in a variety. Third in line of fluctuation is the form and outline of the apple, and with this the core line. Fourth in rank of inconstancy is the tubes, while the stamens, basin and cavity fluctuate least.

As far as could be observed there is very little fluctuation in shape, size or form of the calyx in any one variety of apples. In general, while there are no two apples formed alike in any one variety, yet there is a certain similarity running through one variety that makes them look alike.

In the following table is shown the characteristics of each variety studied as to its fluctuations or constancy. No. 1 standing for constancy, No. 2 for fluctuation:

	Cells	Size	Form	Cavity	Basin	Stem	Tube	Core Line	Stamens	Core	Calyx
1, Janet, 1693	2	1	2	1	1	1	2	2	1	1	1
2, North Carolina, 1441	2	1	1	1	1	2	2	1	1	2	1
3, Pickapoo, 942	1	2	2	1	1	2	1	2	1	2	1
4, Smith, 1775	2	2	2	2	1	2	1	2	1	2	1
5, Limber Twig, 936	2	1	1	1	1	1	2	1	1	1	1
6, Houghtaling, 1067	2	1	2	1	1	1	1	2	1	2	1
7, Ortley, 1166	1	1	1	1	1	2	2	1	1	1	1
8, Rock, 1542	2	1	1	1	1	2	1	1	1	2	1
9, Jones, 1203	2	1	2	1	1	2	2	2	1	1	1
10, Gold Ridge, 1583	2	1	2	2	2	1	1	2	2	2	1
11, Agrippa, 1111	2	2	2	2	2	2	2	2	1	1	1
12, Nancy Jackson, 1224	2	2	2	1	1	1	2	2	1	2	2
13, Shakleford, 1317	2	1	2	2	1	2	2	2	1	2	1
14, Black Warrior, 1537	2	1	2	2	1	2	2	2	1	2	1
15, Nelson, 1402	1	2	2	1	1	2	2	2	1	1	1
16, Huguenot, 1715	2	1	2	1	1	1	1	2	1	2	1
17, Goin, 1709	2	2	2	2	2	1	2	2	2	2	1
18, Gill, 1721	2	2	2	1	1	2	1	2	1	2	1
19, Duncan, 1259	2	1	1	2	2	2	2	2	1	1	1
20, Stark, 1497	2	1	2	2	1	2	2	2	1	2	1
21, William's Early Red, 949	2	2	2	2	1	2	1	2	1	2	1
22, Stone's Eureka, 1037	2	1	2	1	1	1	1	2	1	2	1
23, Nansemond, 1083	1	1	2	1	1	1	2	2	1	1	1
24, Black Annette, 1382	2	1	2	1	1	2	1	2	1	1	1
25, Fink, 1125	2	1	1	1	1	1	2	1	1	1	1
26, Stayman, 868	2	1	2	1	1	2	2	2	2	2	1
27, Kinnaird, 870	2	2	1	1	1	1	1	1	1	1	2
28, Red Siberian Crab, 978	1	2	1	2	2	2	1	2	1	1	1
29, Andrew's Winter, 1523	2	2	2	1	1	2	2	2	1	2	1
30, Crotts, 1267	2	1	1	1	1	1	1	1	1	1	1
31, Red Romanite, 1501	2	1	2	1	1	2	2	2	1	1	1
32, Yates, 1227	2	1	2	1	1	2	2	2	1	1	1
33, Belmont, 1677	2	2	2	1	1	2	2	2	1	1	2
34, Vanoz, 1714	2	1	1	1	1	1	1	1	1	2	1
35, Marshal, 971	2	1	2	2	1	1	1	2	1	2	1
36, Arabka, 1874	2	2	2	1	1	2	2	2	2	2	1
37, Plumb Cider, 1459	2	2	1	2	2	1	2	1	2	2	2
38, Latah, 1378	2	2	1	1	2	2	2	1	1	2	1
39, Hiley Eureka, 16—	2	2	2	1	1	2	2	2	2	2	2
40, Bombshell, 1659	2	2	2	2	2	2	1	2	2	2	1
41, Rome Beauty, 612	2	1	1	2	1	2	1	1	1	2	1
42, Indiana Favorite, 1735	2	1	1	1	1	1	2	1	1	2	1
43, Lawver, 1007	2	2	1	1	2	2	2	1	2	2	2
44, Fallenwater, 10—	2	2	2	2	2	2	2	2	1	2	2
45, Lankford, 1313	2	2	2	1	1	2	1	2	1	2	1
46, Lake Winter, 611	2	1	2	2	2	2	1	2	1	2	1
47, York Imperial, 1086	2	2	2	1	1	1	2	2	1	2	1
48, Loy, 1462	2	2	2	2	2	1	2	2	1	2	1
49, Superior, 1529	2	1	2	2	1	2	2	2	1	2	1
50, Longevity, 1578	2	2	1	1	1	2	1	1	1	2	1

In conclusion it might be said that the investigation, if it were continued with all the different varieties of apples that we have, would bring out the same facts as has been brought out in the study of these fifty varieties.

There is a slight possibility that where only one variety is grown in an orchard there may not be such a great tendency toward fluctuation of characteristics as there would be in an orchard like the State College of Washington orchard, where there are hundreds of different varieties of apples.

THE WASHINGTON STATE ANNUAL CONVENTION

AT the annual convention at Prosser of the Washington State Horticultural Society District Fruit Inspector C. L. Whitney, who was a delegate, delivered one of the principal addresses. His subject being, "The Show Ring." He said in part:

"We are living in a busy, progressive and commercial age. Advertising is an art. We must catch the eye of the passerby and please his taste before he will give up the almighty dollar. We must advertise our fruit and our section of country. How can we do this better than by entering the 'show ring,' and using apples for the purpose. 'By their fruits ye shall know them.'

"There are many beautiful and fruitful valleys in the great Northwest which have already been made famous by the red apple. Among these I will just mention Hood River, Rogue River, Wenatchee and the Yakima Valley. Each one of these valleys is modern up-to-date gardens of Eden. But the beautiful Walla Walla Valley is the original garden of Eden, for does not the good book say, 'And the Lord God planted a garden eastward in Eden and there He put the man He had formed.' Behold, Walla Walla lieth eastward from Hood River. And, again, in that garden of yore all things grew to perfection. The earth brought forth everything necessary for man, without his labor in plowing or sowing. Perpetual spring reigned—flowers sprang up without seed (just like ours).

"Roses bloomed in fragrance and profusion (just like ours).

"In the tree tops sang the birds of Paradise.

"Orchards blossomed and bore fruit for the gods, with a single spraying.

"Rivers flowed with milk and wine, and sweetest honey was distilled from apple blossoms (just like ours).

"Our valley is blessed with abundance of water, lots of cows and whole swarms of bees and vineyards galore.

"In the midst of that garden grew an old apple tree with fruit fairer than the rest. (It may have been a Roman Beauty, for all I know.) Anyway, the apples were large, highly colored, extra fancy, and caught Father Adam's eye at first glance, then down went the fruit, and so you see the apple was the first great advertiser.

"Apples do not only attract attention by their beauty, but they advertise the climate and soil by their size and color.

"All things are judged by comparison, and when apples from the states of Washington, Oregon and Idaho are put in the 'show ring' alongside of apples from Maine, Vermont and Rhode Island, and apples from British Columbia, Montana and Colorado, with apples from Nova Scotia, New York and Michigan ours loom up with undiminished luster, and tell in silent language of a land that is 'fairer' than theirs.

"I find the 'show ring' is good for another purpose—that of putting pride and ambition into our own people.

When we enter into friendly competition with our neighbors from other fruit growing sections at fruit fairs and national apple shows we always learn something, and, whether we win or lose, we go back home wiser and with a firm determination to do better next time.

"Talking about apple shows, why not get up a world's apple show and have apples from every country that grows, or think they can grow apples. In place of holding it a week hold it for a month or two. Make it an educational as well as an advertising feature. Have a regular apple school, lectures and demonstrations from practical fruit growers. Packing contests, pruning contests, marketing problems and many other important subjects. It was a herculian task to get our people to enter the 'show ring,' but when our commercial club put up the money to defray all expenses it was dead easy, and now that we carried off the gold medallion banner at the Third National Apple Show at Spokane we are feeling like Alexander the Great, sighing for more worlds to conquer.

"Our commercial club gave a cash prize of $50 to the merchants of Walla Walla who made the finest display of apples in their windows. Some twenty stores, or more, were beautifully decorated with that king of all fruits. Passersby never failed to stop, look and exclaim, 'Oh. you apple.' In one store apples and diamonds were placed side by side and the apples attracted the greater attention. In another store apples were on display beside the finest millinery. Even bonnets of the newest and latest creation could not detract from the big red apple. This, our first attempt to decorate the stores with apples, being such a success it was planned to hold an apple carnival each year in Walla Walla, and decorate every business house in our city with apples of scarlet and gold.

"While ours is the garden city, it is fast becoming the 'apple city.' Thousands of acres of wheat and alfalfa land are being planted to commercial apple orchards, and in a few years we hope to be placed on the map, and then we will get into the 'show ring' in dead earnest.

"When we enter the 'show ring' we must not only have apples of uniform size and high color, but also the finest of flavor. There should be a tasting committee as well judges at every apple show.

"Apple eating contests would open up a larger market for our apples. We must try and increase the consumption to keep pace with the much talked of over-production. One way to do this is to educate the people to eat more apples.

"Why not get up a train load of prize apples; let each section donate a carload and take them back East to be given away where they will do the most good for advertising purposes. I have no doubt the railroads would transport them free, and the commercial clubs would raise what money was necessary for advertising them in the East. The 'Northwest Red Apple Limited' would be one of the greatest drawing cards from an advertising as well as a business standpoint. The East would know us better. They would see and taste our juicy apples. Short talks could be given and pictures thrown on canvas, literature handed out, and the goods would be right there to speak for themselves. The big red apple, that king of all fruits, from the great Northwest, to which we all take off our hats and hurrah."

A BRIEF RESUME OF THE STORAGE SITUATION

From "The Spy," Organ of the Apple Shippers' Association

AT the last convention it was ordered that the matter of storage of apples in transit be vigorously pressed by the association and that sufficient funds be granted to meet the accounts, expenses to be first approved by the executive committee. The work was taken up by the transportation committee and a special sub-committee appointed with E. N. Loomis as chairman and John B. Frey, N. G. Gibson and W. J. Henry as the other members. A conference was then arranged between this association, the Western Fruit Jobbers' Association and the National League of Commission Merchants. As a result of this meeting a special conference committee representing these associations was organized, consisting of E. N. Loomis, N. G. Gibson, W. D. Tidwell, J. E. Stewart, R. E. Hanley, W. E. Jones, and H. J. Shifferle of No. 131 South Water street, Chicago, as secretary.

It was then determined to submit this proposition to the Transcontinental Lines Freight Bureau and individual lines interested, with a request that the privilege be made applicable in time to move the apple crop of 1911. In accordance therewith proposed rules were formulated for the protection of the railroads as follows:

"Apples, carloads, from any point shown in tariff, may be shipped to any intermediate point, placed in storage, and 19829—BetFrt Moulton 3-22-11 Gal. 63 afterward reconsigned on protection of through rate, under following provisions:

"A—The storage point must be an intermediate point in the same general direction between point of origin and final destination, except that no charge for back haul will be made, when ultimate destination is in the same general direction, or storage point is in territory intermediate via any route from point of origin to final destination.

"B—Storage must be in warehouse furnished by shipper, or owner of property. The carrier not to assume charges for storage, insurance, or other expense accruing at warehouse.

"C—Shipments entitled to storage in transit privilege shall have their expense bills at the storage station stamped, 'To be stored in transit.'

"D—The surrender of paid expense bills, accompanied by warehouse certificate identifying said shipment, will be a declaration by the shipper that said shipment is entitled to transit privilege.

"E—Shipments may be stored in transit for a period not exceeding nine months, but in no case is privilege to be extended beyond July 1 following.

"F—Upon surrender of paid in-bound expense bills, shipments will be rebilled from storage point to final destination, plus a switching charge not to exceed $5.

"G—The through rate in effect on date of shipment from point of origin shall be the rate to be protected."

Much work has been done by this committee and as a result the number of associations working for the privilege is continually increasing, and the railroads themselves have taken an increased interest in the matter. The central freight committee, located at Chicago, has voted in favor of granting this privilege. This committee acts in an advisory capacity to the Central Freight Association, comprising all the transcontinental lines entering Chicago, and from this center the movement would be expected to extend to the transcontinental lines entering New York. In addition, prominent banking interests on the Pacific Coast are actively at work urging the Western lines to grant this relief.

It is conceded that within a few years the states of the Northwest will have to market 100,000 cars of apples annually, as against the 15,000 cars at the present time. This is a tremendous increase and presents a problem difficult to solve.

Some of the reasons why this storage in transit privilege should obtain are given in the words of Mr. Loomis as follows:

"The great trouble with the movement of the crop of box apples in a satisfactory way has been the lack of facilities for distribution. The crop is moved in a month and a half; it requires nine months of the year to consume it; storage facilities must be provided at the most favorable points to hold this crop during that period of time and to allow it to go to any market that most needs the supply. At the present time the box apple crop is congested at Chicago and New York and no efforts are being made to increase the consumption of box apples at other cities. According to the proportion of wealth, half the box apple crop should be consumed in the East between Chicago and New York. At the present time only one-quarter of the crop is being there consumed. The granting of this privilege would particularly stimulate the demand in the many large cities between Chicago and New York. It would greatly benefit the railroads in an increased amount of traffic, especially on the Eastern lines between Chicago and New York, probably to the extent of a million dollars annually. It would also greatly benefit the growers of box apples in providing a systematic scheme of distribution; it would allow their crop to be marketed where it is most wanted and also by scattering it among the cities of the United States prevent a glut or congestion in any one market. It would in addition greatly help all the cold storage warehouses at all cities on transcontinental lines and would particularly place on a prosperous basis the warehouses at Chicago and those in Western New York. The latter would be assured of full houses on any short year. In addition, it would greatly help the apple industry. At the present time competition is concentrated in one or two sections. With this privilege capital would be induced to invest in box apples on equal terms with barreled apples, and thus it would be distributed throughout all apple sections, thereby tending to greater uniformity and stability."

As to expense, the three associations have each appropriated $500. Several cold storages have also contributed. All interests to be benefited should be anxious to share the burden, on the principle of the "square deal."

RESOLUTIONS AND RULES ON STORAGE IN TRANSIT

AT a conference of the authorized representatives of the Western Fruit Jobbers' Association, the National League of Commission Merchants of the United States and the International Apple Shippers' Assocition held in the La Salle Hotel, Chicago, on the 12th day of December, 1910, the following resolution was unanimously adopted:

"Resolved, that owing to the growing necessity for storage in transit of box apples from the West, to the end that a broader and more equitable distribution may be accomplished, thus fostering and protecting the industry, increasing the traffic and aiding the furnishing of equipment to move the crop, the appended rules governing such storage in transit of apples be submitted to the Transcontinental Lines Freight Bureau and individual lines interested, with a request that said rules be adopted in effect and such storage in transit privilege be made lawfully applicable in time to properly move the apple crop of 1911."

Apples — carloads — from any point shown in tariff may be shipped to any intermediate point, placed in storage and afterward reconsigned on protection of the through rate under the following provisions:

A—The storage point must be an intermediate point in the same general direction, between point of origin and final destination, except that no charge for back haul will be made when ultimate destination is in the same general direction or storage point is in territory intermediate via any route from point of origin to final destination.

B—Storage must be in warehouse furnished by shipper or owner of property. The carrier not to assume charges for storage, insurance or other expense accruing at warehouse.

C—Shipments entitled to storage in transit privilege shall have their expense bills at the storage station stamped, "To Be Stored in Transit."

D—The surrender of paid expense bills accompanied by warehouse certificate identifying said shipment will be a declaration by the shipper that said shipment is entitled to transit privilege.

E—Shipments may be stored in transit for a period not exceeding nine months, but in no case is privilege to be extended beyond July 1st following.

F—Upon surrender of paid in-bound expense bills shipments will be re-billed from storage point to final destination at balance of through rate, if any, from initial point of shipment to final destination, plus a switching charge not to exceed five dollars.

G—The through rate in effect on date of shipment from point of origin shall be the rate to be protected.

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RESOLUTIONS of committee of the Central Selling Agency for Northwest fruits:

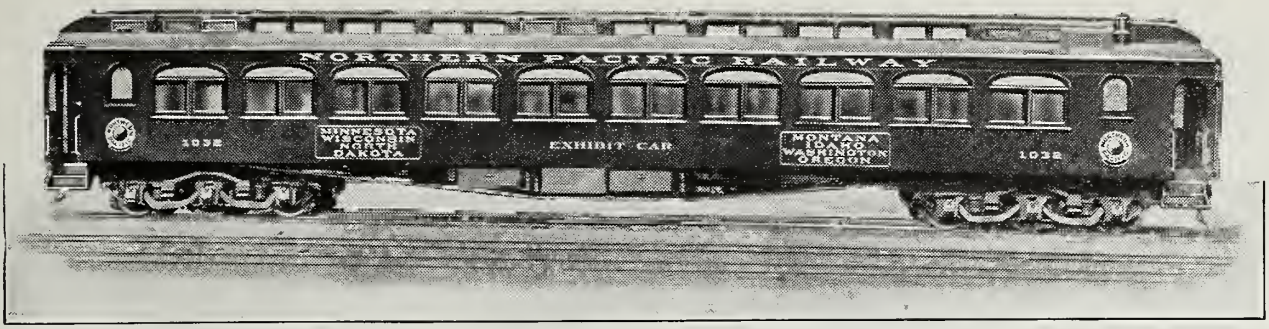
Whereas, the greatest success of the important industry of apple growing in the Northwest demands that the present apple marketing season of one hundred days be extended to at least nine months; and

Whereas, to accomplish this, some plan must be inaugurated to get a considerable portion of our apples direct from the orchard into cold storage; and

Whereas, the present and prospective storage in the orchard districts is entirely inadequate, and inadvisable for the reason that our apples must be moved through the Rocky Mountains before heavy freezing weather, and be nearer the consuming markets for distribution during winter months; therefore, be it

Resolved, that we urge and demand that a through rate allowing storage in transit be established, thus affording our industry the same privileges accorded others, notably the millers, who have a milling in transit rate, and the stockmen, who have a feeding in transit rate.

Resolved, that this meeting, representing the apple growers of the Northwest, appoint a standing committee of five to present our demands to the proper authorities and co-operate with other organizations now working to secure a storage in transit rate on apples.



A MODERN TRAVELING AGRICULTURAL DISPLAY

PRACTICALLY ready to start on its ten thousand mile tour, resplendent in fresh varnish and polished brass, the Northern Pacific's Northwest exhibit car is "chock full" of evidence of the productivity and varied resources of the states along its lines: Minnesota, Wisconsin, North Dakota, Montana, Idaho, Oregon and Washington.

It is not at all a new plan to start out such a car, for the Northern Pacific several years ago equipped a similar car, which was on exhibition at the World's Fair in Chicago. This car afterwards made numerous tours, advertising the Northwest.

However, the new car which starts out at this time is of latest model, seventy-five feet long, lighted by electricity and acetylene gas, equipped with extra wide windows, six-wheel trucks and all other details of an up-to-date passenger coach.

It is an event long to be remembered, especially in a smaller town, for an exhibit car of this character to be pushed in on the siding and thrown open to the inspection of those who could in no other way see the products of the soil from such a wide range of territory as that lying between the Great Lakes and the Pacific Ocean. The fertile wheat and corn fields of Minnesota and North Dakota, the farms, orchards and gardens of Montana, Idaho, Washington and Oregon, have all contributed their share to a grand display which for excellence and diversity has never been excelled in any agricultural exhibit, either stationary or on wheels.

A great many of the exhibits in the car were secured from the Minnesota, North Dakota and Montana State Fairs, from the Dry Farming Congress recently held at Spokane, and from numerous county fairs held last fall in Washington and other state. By this method the Northern Pacific has secured a representative display from all these states such as has never before been assembled.

The itinerary of the car is being carefully worked out with a view to exhibiting it in those sections of the Eastern and Southern states from which thousands annually migrate to the Great Northwest beyond the Missouri River. The average Easterner, not inclined to think of the West beyond the Big Muddy as a vast region of cities, fields and farms where state boundaries merge in a sameness of agricultural landscape, will be shown how attractive and how productive are the fields lying along the "Scenic Highway Through the Land of Fortune."

The car will be accompanied by representatives of the passenger and immigration departments of the road and by a lecturer who will give illustrated talks to supplement the exhibit. Literature will be liberally distributed to further acquaint Easterners with the great Northwest.

While chief interest in the car will be among the farming class, yet it is planned to make stops in the smaller towns to show those who labor at trades and in factories the advantages of outdoor life and independence on the orchards and farms along the Northern Pacific.

UNIQUE SIGN MADE ENTIRELY OF GRAIN SEEDS

A UNIQUE feature of the exhibit material which the Northern Pacific Railway has assembled to place in its exhibit car which will tour the Eastern and Southern states is an immense trade mark of the company made out of grain seed. The accompanying picture will give some idea of the appearance of this symbol, the frame being six feet square, and the trade mark and lettering mounted on a background of green baize. The outer rim of the trade mark is a rope of straw. The lettering "Northern Pacific" is made of alfalfa seed, the background in the outer circle is No. 1 Northern wheat, the upper half of the "Monad" is red millet, the lower half is rutabaga seed, the lettering "Yellowstone Park Line" and "Northern Pacific Railway" is timothy, the background of the lower panel is ground flax, and the lettering "Scenic Highway Through the Land of Fortune" is clover seed. Taken altogether, it is a most attractive piece of workmanship, the coloring being brought out in an ingenious manner. It took one man three weeks to make it.

Many other interesting and instructive exhibits of the products of Minnesota, North Dakota, Montana, Idaho, Oregon and Washington fill the Northern Pacific exhibit car to overflowing with "show me" evidence of the great fertility and varied resources of these states.

HISTORY OF SPRAYING IN THE PAJARO VALLEY

BY C. W. WOODWORTH, EXPERIMENTAL STATION, BERKELY, CALIFORNIA, AT WATSONVILLE APPLE ANNUAL

THE magnificent display of this apple show justifies a feeling of pride in every Californian. These products represent not only the richness of the soil and the perfection of the climate, but testify even more to the enterprise, courage and faith of the people of this section of the state. For be it known that such results as have been attained in this valley represent the resolute facing of difficulties and the conquering of them. It is a high honor for any of us to have been associated in any way with the solution of the problems that have confronted these apple growers and to share even to a small extent in this triumph.

It is undoubtedly true that nowhere in the world is there an area planted to any crop to the extent of the apple orchards of this valley, where spraying is so universally and efficiently done, and there is no similar area where such difficulties had to be surmounted in order to place spraying on a practical basis. The story of the horticultural achievements of the Pajaro Valley will always include the contributions here made to the means of controlling the insect pests.

Just a quarter of a century ago I had the privilege of taking part, under the direction of Professor Forbes, in Illinois, in the first thorough scientific experiments made to test the efficiency of arsenicals in the control of the codling moth. This method has gradually been extended until now spraying with these substances has become an essential part of the practice of apple growing in every region which figures in the commercial production of this fruit.

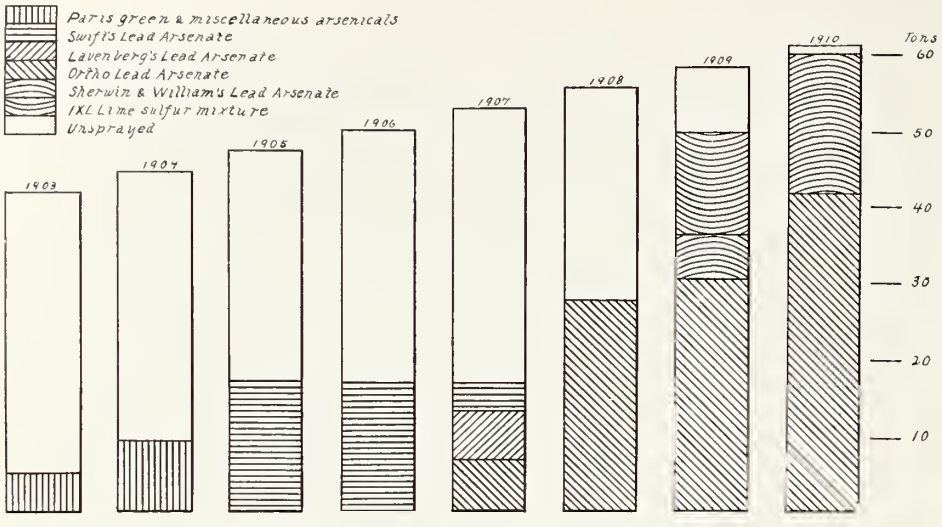
Just twenty years ago Professor Wickson conducted the first experiments in spraying for codling moth on the Pacific Coast, and my first task on coming to the state was the preparation of the notes on these experiments for publication in the report of the experiment station. Spraying was not immediately taken up in the Pajaro Valley, though the codling moth had already reached this region, and wormy fruit became very prevalent. A few of the more enterprising orchardists finally began to experiment with sprays, but could not obtain satisfactory results, though some of them continued their efforts year after year.

The conquering of the codling moth has been the work of the last eight years. Previous to 1903 spraying for the codling moth was not extensive enough to produce any appreciable effect on the apple market in this valley. Even today the good which can come from spraying is only a little over half realized. While we have a right to felicitate ourselves upon the progress thus far made—that this valley today leads the world in this phase of the fight for perfect fruit—let us realize that this pre-eminence can only be maintained by improving the spraying practice over the greater portion of the present acreage, bringing it in line with the best practice in the valley. Many orchards are today experiencing a loss from codling moth, notwithstanding their spraying work, of between 10 per cent and 20 per cent, while adjacent orchards, under identical climatic conditions, suffer a loss of less than one per cent. An insignificant increase in the cost of spraying would easily add two or three hundred cars of merchantable fruit to the output of the valley. As we recount the efforts and achievements of the last few years may we gain a renewed determination to permit no pause in this forward movement.

When the call for help was sent to the university in 1902 the staff of the entomological division consisted of a single instructor. With the funds contributed by the two counties he was enabled to bring into the field a corps of four assistants, all students of the university. All of these have made good. Mr. Clarke was shortly afterward called to Alabama as professor of entomology and later recalled to California as assistant professor of horticulture, and given charge of the Farmers' Institute work of the state. Mr. Kirkman has for years successfully managed a large nursery in the San Joaquin Valley. Mr. Hunter is the horticultural commissioner of San Mateo County, whose successful work against the mosquitoes of the Milbrae marshes has been particularly notable, and Mr. Mitzmain did good service in the study of fleas in connection with the bubonic plague work in San Francisco, and is now in the government serivce in the Philippines, studying the insects associated with diseases of domestic animals.

With the aid of these young men we were able to carry on rather extensive experiments and to study the life history and habits of the insect.

The primary object of our work was to prove that the arsenicals were not inefficient, as those who had previously experimented in this valley had concluded, and the work was eminently successful in demonstrating this fact, though the spraying program generally recommended was found to be entirely inapplicable under the conditions existing in this valley. This success, however, was something like the successful operations we sometimes hear about in the hospitals in which the patient dies. The fact (entirely unanticipated, one that brings this region in striking contrast with all other sections where spraying for codling moth is practiced) that arsenicals, when used in the most approved manner and with all the known precautions, produced serious damage to the foliage when the necessary treatments are made to secure the fullest control of the insect. In one orchard particularly the loss was very much more than would have been produced by the codling moth had the orchard remained untreated. Long before the end of the season it was seen that the most serious problem was how to so apply the arsenicals that the foliage should not be damaged. On account of this development of the situation another man was added to the staff—another student—Mr. Volck, who had already done good service in another part of the state in the study of the injuries produced by oil in spraying citrus trees. He has remained with this problem now over seven years. To his ability and untiring effort and devotion more than to anyone else is due the splendid victory against the codling moth. His work was full of failures, but as soon as one thing failed he at once



tested another. He was never defeated, nor did he show discouragement. A man with less of the bulldog perseverance would not have succeeded, nor a man with less skill as an experimenter—less full of expedients. His first work seemed to point to success from a water-proofing of paris green, but the next season's spraying work showed this to be a failure, and paris green, which up to this time had everywhere been regarded as the standard remedy for codling moth, finally had to be discarded.

Mr. Volck's work in 1904 consisted very largely in testing out all the brands of arsenicals on the market, other than paris green, and particularly the lead arsenates. Despite the serious burning of some orchards in 1903 the results in codling moth control so pleased the growers that a considerably larger acreage was sprayed in 1904, and since most of this was with lead arsenate, and the season not particularly bad for burning, they became enthusiastic enough to spray about a third of the entire bearing acreage in 1905. The gradual extension of spraying is graphically shown in the accompanying chart.

The spraying in 1905 was almost exclusively with Swift's arsenate, since that had proven best in the experiments of the previous year. The results obtained during this year were the most disappointing of the whole conflict. While the codling moth was well controlled the amount of burning was so large that the progress of spraying was entirely checked. For three years there was no appreciable increase in the number of acres sprayed.

For this reason, in 1906, two more students were sent into the valley. Mr. Parker, who has just been appointed to a responsible position in the division of entomology of the United States Department of Agriculture, and Mr. Luther, who has remained in the valley, and who has been a very important factor in the final solution of the problem. During this year hundreds of arsenicals were made up and tested on foliage. The most significant discovery of the year 1906 was that where a lead arsenate was so compounded that all the arsenic acid present was combined with lead no injury was produced on the most delicate foliage. Such a compound is known as a neutral, or Ortho arsenate of lead.

At that time no manufacturer was able or willing to produce an arsenate of lead of this description, and to this day, excepting the product manufactured here at Watsonville, there is no strictly neutral lead arsenate on the market.

Other apple regions have a climate permitting the use of ordinary arsenates of lead, or of paris green for that matter, but here the control of the codling moth, with safety to the tree, is absolutely dependent upon the use of the kind of lead arsenate now only manufactured at Watsonville. The manufacture of such an arsenical presents many practical difficulties, and normally would have cost more money than the common lead arsenate, but by the working out of new methods this material has been produced at a cost to the grower decidedly lower than that previously charged for the ordinary lead arsenates, and this saving has turned back into the pockets of the growers much more than the investigation has cost. In 1907 Mr. Luther undertook the management of a factory incorporated as a private enterprise to produce this compound. In the neighborhood of six tons of lead arsenate was manufactured that year. About the same quantity of Lavenberg's lead arsenate and a smaller amount of Swift's was used. Both of these burned foliage much as in 1906, while the Ortho lead did no burning whatever; therefore, in 1908 there was practically no arsenical used other than the Ortho brand, and the area sprayed was greatly extended.

In 1909 still more territory was sprayed with the Ortho lead, and, in addition, a small amount with the Sherwin-Williams arsenate of lead. About a carload of the IXL mixture was also sold to orchardists upon the misrepresentation that it would be effectual against codling moth. This shows how easily otherwise intelligent farmers may be gulled, but it is not likely that any more of that product could be sold in the valley for several

years to come, no matter how skilled the salesman was who made the attempt.

The case of the Sherwin-Williams product is different. This lead arsenate ranks with the best brands on the market. In other regions it is a safe and effective insecticide. During the season of 1909 the burning of foliage was not very pronounced, but in 1910 the losses from this source were very severe. We thus have in the experience of 1909 and 1910 with the Sherwin-Williams arsenate simply reproduced the experience of the valley with Swift's arsenate during the seasons of 1904 and 1905.

Orchardists should insist that until manufacturers are ready to produce a strictly neutral lead arsenate they have no right to sell their products in this valley.

The danger from the use of the Sherwin-Williams lead was understood and announced by Mr. Volck, but notwithstanding his warnings buyers could be found, and the material was sold. It was not contended that this lead was a strictly neutral lead arsenate. The presence of an excess of arsenic acid was easily determined by chemical tests, and the foliage test entirely confirmed the chemical test. The only argument was that such compounds were safely used elsewhere. Had this valley been comparable with other sections it would not have required eight years to bring the growers to practical unanimity as to the value of spraying. There would not have been the reaction against spraying during the years 1906 and 1907; indeed, it is probable that the special services of the university would not have been required at all, but the growers themselves would have brought spraying to a successful issue during the twelve years that intervened between the successful experiments of Professor Wickson and the beginning of the codling moth investigations in 1903.

The one thing that the experience of these eight years has demonstrated is that the conditions are peculiar. The good to come from this years' experience should be that hereafter a lead to sell in this valley must correspond with the standard found necessary under our peculiar conditions. There is no reason why other manufacturers than the local firm might not produce these goods, but up to date none of them has done so.

This brings up the desirability of a state insecticide law. There is certainly a great present need for such a law, and it should commend itself to the active support of everyone here present. No doubt last year's experience with the IXL compound would scarcely have been possible, and this year's experience with a pyro lead compound would have been less likely because of the greater respect many orchardists would have had for warnings from a state office. Nothing, however, seems sufficient to protect some farmers from plausible agents, as was witnessed in this valley this year when some of them were persuaded to part with their money for an absolutely fraudulent fertilizer compound—a product which it should be illegal to offer for sale in the state as a fertilizer.

The discovery and adoption of a safe arsenical is an essential factor, without which successful spraying is impossible, but we should not lose sight of the fact that other questions must also be considered if we are to secure the full benefits of the practice. Doubtless next year no dealer in the valley can afford to offer for sale any lead arsenate against which there is any suspicion of lack of neutrality, and the question of a safe arsenical will have been settled. Then the only questions remaining are those of quantity, manner of spraying and time.

The former of these I propose to discuss with the growers of the valley when the agricultural train comes to this section in a few months from now, and will then have apparatus by means of which I can illustrate my remarks. Today I will limit myself to the discussion of the time for spraying.

The experience of these eight years has abundantly proven that to produce the best results we cannot follow the practice of other regions.

In the Pajaro Valley alone of all the regions where apples are grown commercially we have one section where trees need not be sprayed at all for codling moth. The section of the valley towards the sea from Watsonville is a naturally immune area. The immunity is due to the fact that the evening fogs and cold winds from the ocean reach this region so early as to almost invariably prevent the flight of the moth, and in consequence the laying of the eggs. Sometimes after worms have been taken into an orchard of this district in apple boxes a few wormy apples are found for a year or two, but never enough to be of any significance. This immunity does not extend further inland than the City of Watsonville, for as soon as a point is reached where the moth will be able to make a flight once or twice in a month it may be able to lay its full quota of eggs, and the worms become as numerous as though the moth could fly every evening. Nevertheless the condition which results in an immune area below the city profoundly affects the life history of the insect throughout the whole valley. This influence of the ocean is what has made the climate of the Pajaro Valley so peculiarly adapted to the production of the type of apple grown here to such perfection.

In bulletin No. 155 we divided the work of codling moth control into three campaigns. The first to consist of the work of putting poison in the blossom cup, the second what other sprayings were found necessary to control the first brood of worms and the third the sprayings against the later broods.

The accumulated evidence of eight years of experimentation and observation all shows that the blossom cup campaign is of no practical value in any part of the Pajaro Valley.

Upon this point the best practice of our growers stands in most striking contrast with that of many other regions, and is most sharply opposed to the recommendations found in the greater part of the literature on the control of the codling moth.

At the present time there is something of a controversy between advocates of numerous sprayings and of those who claim better results from a single spraying. Both parties believe in blossom cup spraying, and the single spray advocates contend that if the blossom cup work is done thoroughly enough there will be no necessity for any supplementary sprayings. The outcome of the work in this valley is the discarding entirely of the blossom cup work. This does not in any way call in question the value of blossom cup spraying in other regions; indeed, the evidence seems to be conclusive that in some regions the single spray method produces results that are as good as can be produced by any method, but simply emphasizes the difference corresponding to the climate of the different localities.

One condition which renders the single blossom cup spraying an impossibility here in the Pajaro Valley is the long period of blooming. Before a tree is in full bloom one often finds fruit on the tree as large as the end of one's finger. If it were necessary to place the poison in every blossom cup at least three sprayings would have to be given during the blossoming period.

A second condition rendering blossom cup spraying inefficient in this valley is the fact that comparatively few of the worms enter the fruit at this point. This difference in the habit of the young worm corresponds with the fact that the fruit is almost always larger before the worm attacks it, and in every district where worms attack larger fruit a large proportion enter on the side. Here it is the first generation that makes the side entrance, and elsewhere the first generation attacks the fruit when very small. The same cold spring water that causes the long protracted bloomings of the trees holds back the appearance of the moth still more, and instead of all coming forth simultaneously the over-wintering individuals are emerging during two or three months. Most of the eggs are not laid till the fruit is well advanced.

The basis for the discarding of the blossom cup spraying, however, was not so much this observation of the peculiarities of the life history as the fact that perfect control, as good as is obtained by any method, is the result of a spraying program which absolutely ignores the blossom cup work. As far as is known none of the orchardists in this valley have ever practiced blossom cup spraying. Mr. Volck has employed the term "blossom cup spraying" to describe the effort to wet the hairy portion of the apple just outside of the blossom cup, but this is not at all what is meant by the term elsewhere. Others mean the inside of the cup, where the pistil and stamens arise.

Almost complete absence of worms at picking time can be secured when no

effort at all is made to control the first generation of the insect. This practice, however, is not to be recommended, and is indeed not the present practice of any of the growers. However, if an orchardist desired to make a single spraying do for the year an application in August would give, in this valley, the best degree of control that could be secured by any single application. The reason that the first generation generally produces but little or no loss to the crop is the fact that the dropping of a few infested fruit in mid-summer simply thins the crop and decreases the number of apples, but not the number of pounds of fruit finally harvested. The wormy fruit found at picking time is practically all the result of the work of the later generations of worms, and a thorough spraying in August will destroy the larger proportion of these.

The reason why the single August spraying is not recommended is that while such spraying prevents a large part of the fruit becoming wormy it will not prevent the spots produced by the very young worms before they get enough poison to kill them. These spots are about as conspicuous as those produced by the San Jose scale, and, of course, should be avoided as far as possible. A single spot of this kind does not at present cause fruit to be graded down, but it is certainly objectionable.

The present practice of endeavoring to destroy as many as possible of the first brood is correct, according to our present knowledge of the problem, provided they are supplemented by one or more later sprayings. Such a large proportion of the apple orchards are sprayed that the wormy apples now allowed to rot on the ground or sent to the dryers are almost entirely due to the neglect of this very necessary part of the program of effective spraying.

The spraying in August will justify itself in the financial returns from the crop at least equal to, and in most cases very much better, than any of the earlier sprayings. There may be some improvement possible in some orchards by increasing the thoroughness of the application, and perhaps also in the better timing of some of the earlier treatments, but in the majority of cases the spring work is well done, and all that is necessary to bring up the general average till it fairly approximates the best practice is the addition of the later sprayings. This is, therefore, the one point where we can expect to obtain rapid and tangible results. The general adoption of the autumn spray will add hundreds of carloads to the output of the valley and a corresponding amount to the profits of apple growing in this valley. In these later sprayings the necessity of using a strictly neutral arsenate is particularly apparent. The poisoning effect of arsenicals shows itself in two very different ways. The burning of the edges of the leaves is apparent to everyone in cases where considerable quantities of soluble arsenic enter the plants; sometimes quite as serious results may come, however, without characteristic scorching. Chronic poisoning, showing itself only in the yellowing and dropping of the leaves early in the fall, prevents the development of the full size, sweetness and crispness of the apple. In extreme cases this chronic poisoning of arsenic may result in an almost complete loss of the crop on account of their small size and inferior quality. Fortunately for the growers in this region a perfectly neutral arsenic is obtainable, and it is possible to determine both by chemical and foliage tests the character of such an arsenical, and there is no longer any excuse for omitting this spraying, which otherwise would be so dangerous as to render it problematical whether their application would be justifiable. If next year is to see the same advance in spraying that the valley has experienced the last three years it can only be done by improving the spraying practice in the way here suggested.

At the beginning of my remarks I stated that no equal area in the world showed so universal and efficient spraying. It should not be understood that there are numerous smaller areas that are better treated; indeed, it seems to be generally conceded that many of the smaller valleys in the Northwest produce fruit which averages much freer from culls than does the Pajaro Valley. It should be our ambition to not only maintain the pre-eminence of amount of spraying, but to produce fruit which will average equal to the best, notwithstanding the fact that in some particulars we have greater difficulties to overcome.

The codling moth is by no means the only cause of cull fruit, nor is it the only insect trouble that has been investigated in this valley. Extensive and significant experiments have been conducted against the tussock moth or horned caterpillar, the canker worm, the tent caterpillar, the woolly aphis and the two species of leaf aphids. Only the tussock moth has been discussed in bulletin form, but others would have been presented by the university but for the shortage for several years in printing funds.

Perhaps quite as notable as the positive results has been the immense quantity of negative results, such as those secured by the detailed study of the birds of the Pajaro Valley, which also awaits publication, and those produced by the testing out of hundreds of arsenicals. We trust that ultimately we will be in a position to put these results in tangible form for

future students of the subject. We are more interested here, however, in the positive results, and I need only point to the very material progress made in the testing of the efficiency of insecticides and their foliage neutrality and the discovery of new methods of manufacture. from which the orcharidsts of this valley are already receiving benefits. Among these we wish also to call your attention to the arsenite of zinc. This has proven to be the safest of the arsenicals that can be procured in the form of a dry powder. It is not so safe, of course, as the neutral lead arsenates, but has been used without very serious evidence of burning in the orchards where dusting has been adopted instead of spraying. Dusting is usually entirely unsatisfactory, and has been condemned by a great many of the Eastern experiment stations. Here in the Pajaro Valley, however, undoubtedly because of our persistent fogs, results almost, if not quite, equal in efficiency to those obtained by spraying are secured from dry applications by quite a number of our orchardists. There is no doubt that the zinc arsenite stands foremost at the present time among the available arsenicals with high arsenic content. Its particular value in the Pajaro Valley lies in its availability for use in spraying for the tussock moth early in the spring when the danger from arsenic injury is at its minimum. This gives us a better means of control than that recommended in our bulletin No. 183 on the tussock moth.

Mr. Volck has also made great progress in clearing up the problems associated with the manufacture of emulsions, miscible oils and soaps. A phase of this work which is bound to have very important results is the progress made in the incorporation of nicotine. I trust that before long the opportunity will come for the presentation of the results of these investigations in bulletin form. Mr. Volck's association with the California Chemical Spray Company has given him unusual opportunities for perfecting the manufacturing side of these preparations and has made it possible for the growers in this valley to immediately avail themselves of the result of the investigations.

Among the triumphs in the manufacture of insecticides, one that stands second only to the creation of a neutral arsenate, has been wrought out through the work of the last three years, whereby the grade of commercial lime-sulphur solution has been steadily advanced till now it reaches a standard of 36 degrees Baume, a strength one-fifth higher than any found in the market three years ago, and decidedly higher than the output of any other factory in the United States or in the world. This has been done without increasing the cost to the grower, and is, therefore, equivalent to a reduction in price of twenty per cent. The production of this lime-sulphur mixture commercially in this valley has resulted in quite as notable an increase in the amount of spraying for San Jose scale as that indicated on the chart in the case of spraying for codling moth, with the difference, however, that work against the San Jose scale does not require a treatment each year, therefore the number of acres unsprayed in any particular year will always remain larger than that treated. The amount of lime-sulphur solution applied to the orchards in this valley this year exceeded 1,600 barrels.

I will not attempt, however, to discuss in detail the development of this process, nor refer to the great progress made in the control of the mildew, but will close with the thought that the orchardists in this section deserve all of the success that they have secured through these investigations, since they have shown a long-sighted policy, not only in the inauguration of the investigations in 1903 and the maintenance of the work through the succeeding years, but by their persistence, notwithstanding the discouragements of 1905, and I rejoice, as I know you rejoice, in the fact that this investigation has resulted in the establishment in your midst of such a manufacturing plant as that of the California Spray Chemical Company. Of course my own first interests are in the scientific results obtained, but I have little doubt that this factory is destined to continue in this valley as a more efficient living influence than the direct work of the university toward the production in the highest quality of fruit in this valley.

FRUIT GROWING IN THE ROCKY MOUNTAINS

BY E. R. BENNETT

FRUIT GROWING as a commercial business has been largely developed within the past one hundred years. America—that is the United States and Canada—leads the world in its output of fruit, particularly fruits of the temperate zone. The apple, though a native of the Old World, reaches its highest development and greatest production in North America. In the colonial days the apple was grown and used extensively in the eastern part of the United States, but the varieties were for the most part inferior seedlings, and the apple was utilized largely in the making of cider and other alcoholic products. This probably accounts for the lack of interest taken in the early history of apple growing in the United States in developing better varieties of fruit.

Another factor that may have been somewhat responsible for the conditions that existed was the fact that apples, and in fact all kinds of fruits, were produced one hundred years ago without any particular care. The apples of New England may be said to have grown wild, and after they were first planted by the settlers the squirrels carried seed into the stone walls that soon produced trees, and even now a large part of the apple production in parts of New England comes from these seedling trees that are growing along walls and fence rows of the New England farms.

The many diseases and insect pests that have to be contended with at the present time were largely unknown in those days, and good apples of their kind were to be had from any of the farms from New England to the frontier.

A half century ago apple growing was more or less profitable in connection with the general farming of the Central States, and the apple orchard was one of the features of every Michigan, New York or Illinois farm. A few years later the diseases and insect pests became so prevalent that it was difficult to grow apples that were at all salable, or even fairly edible. Up to this time apple growing, or in fact fruit growing of any kind, can hardly be said to have been an industry. When the diseases and insect pests made apple growing as a side issue unprofitable the opportunity for apple growing as an industry became possible. In fact from this date—that is, twenty-five to forty years ago—may be traced the rise of fruit growing as an important industry in the United States. The experiment stations became active in working out remedies for the various troubles that beset the fruit grower and individuals began seeking for varieties that were better adapted for culinary uses and as dessert fruits.

The old farm orchard of the East has become largely a matter of history or sentiment, and has to a great extent passed away, as practically none of them has in the past fifteen or twenty years produced fruit enough to make the orchard worth leaving on the land. Even in the past ten or fifteen years the fruit growing principles and practices have very materially changed.

Fruit growing is an intensive business, and the cost of production is necessarily high whether the returns are large or small. As a result only those places will succeed in commercial fruit growing that have all conditions uniformly favorable.

Of the different factors that are essential in the business we mention, first, the location. This must be where the soils and climate are at least fairly congenial to the wants of the particular fruit to be grown. The next factor that must be considered is that of distance from and availability of markets. There are many districts that are too inaccessible to make it commercially profitable to grow fruit. Another factor that must be considered in fruit growing is the comparative immunity from diseases and insect pests. No place is entirely free from all diseases and pests, but some places are more subject to certain diseases than others because of climatic conditions or geographical location.

Different species of fruit, and even different varieties of the same species, need different conditions under which to reach their best development. Most of our fruits, however, are cosmopolitan in their wants, and may be grown fairly successfully on a great variety of soils and under many different conditions. The apple in particular, although it demands a fairly rigid climate to reach its highest quality, is grown from far north in Canada to the Southern States.

At present fruit growing in the United States and Canada, particularly apple growing, is divided into five great areas or districts. Each of these has its peculiar advantages of location and climatic conditions. Each of these districts is also competing with the others in the markets of the world. The first and oldest of these districts is that extending from Nova Scotia through Northern New England to the Great Lakes. This area is characterized by a short season, with an abundance of moisture. Because of these conditions the quality of the fruit in this district is uniformly high. On the other hand, the humid climate very little of the stringiness so common makes favorable conditions for the development of all the fungous diseases that trouble fruit growing, and because of the age of the industry in this district all of the insects that are known to fruit growers have to be combated. As a result this area produces the maximum of high quality, but imperfect fruits.

The next district is that of the Appalachian Mountain States, running from New York to Virginia and Kentucky. This district is characterized by a longer season, but with a maximum of rainfall. The fruit produced in these districts is not uniformly as high quality as that in the North, and the fungous diseases and insect pests are practically the same as in the first district mentioned.

The third great fruit growing area is that known as the Ozark district, embracing part of Kansas, Nebraska, Missouri, Arkansas and adjacent states. This area is characterized by a long season, with a fair amount of moisture. Insect pests and fungous diseases are practically the same as that of the previously mentioned districts, and the long season tends to produce an excess of tough, woody tissue in the fruit. In this region such varieties as Ben Davis, Gano, Missouri Pippin and Arkansas Black are largely grown.

The next important fruit growing section is that of the Rocky Mountain district, embracing Colorado, New Mexico, Utah, Idaho, Montana and Wyoming.

The fifth important division is that of the Pacific Coast, including California, Oregon and Washington. This district, because of its semi-arid climate, is comparatively free from fungous troubles, and because of its comparative newness is also free from the many insect pests of the East. As a result the fruit is characterized by freeness from fungous diseases, but owing to the long season it is not so good in flavor and texture as that of the North, or the Nova Scotia district.

The Rocky Mountain district has some characteristics that make it different from any of the other four areas. Some of the principles in horticulture are involved that are worth while for our fruit growers to keep in mind. First, our high altitude gives us a short season that corresponds with that of the Canadian districts. The result of this is to make a fine or delicately tissued fruit. This fruit will not stand handling as well as that of the Ozark district, but so far as tissue goes no better quality can be grown anywhere. The most important feature to keep in mind, however, is the principle that high altitude reduces the flavor. At first this might be thought to be a disadvantage to our fruit growers. If recognized and properly taken into account it does not need to be a drawback, and in many cases is an advantage. The principle is well illustrated from the celery and cauliflower growing of this state. In lower altitudes these vegetables tend toward a stringy, tough tissue, with a strong flavor. In the high altitudes of Colorado neither of these characteristics is noticeable. The celery is crisp, with in the East and none of the rank, strong flavor so common there. Other illustrations might be given, but these are sufficient to demonstrate the principle.

In applying this principle to our fruit growing we can readily see that it is necessary for us to grow those varieties of fruit that will stand cutting down in flavor and still leave the quality good. This is best illustrated by the Jonathan apple. In New York and New England the Jonathan apple is a decidedly acid fruit. With us the Jonathan is a mild sub-acid fruit. The toning down of the high altitudes is just what the Jonathan needs to give it the delicate flavor that is desired to make it a valuable dessert fruit. The Baldwin, which is grown more than any other apple in New York and New England, is a mild sub-acid fruit in that district. Here the Baldwin is so deficient in flavor as to be practically valueless as a Colorado apple. For this reason the varieties adapted to Colorado are those that are strong, or, as you might say, heavy flavored in lower altitudes. Many thousands of dollars have been thrown away in Colorado because this principle was not recognized and acted upon in the earlier days of fruit growing in the state. Even now our old orchards are largely made up of such varieties as Ben Davis, Whitney Crab and other varieties even more worthless. It is probable that these are present in the orchards largely because of a prevailing notion that the better varieties were not sufficiently hardy for our climate. We now know that the best varieties that are obtainable are sufficiently hardy to withstand the climate of Colorado, even as high as 7,000 feet in some parts of the state.

In looking over the situation of apple growing in the United States it would seem to us that our great advantage is in the fact that we can produce as good a tissued apple as the best districts of America; we have almost no fungous diseases to contend with, comparatively few serious insect pests, and by selecting the proper varieties may grow a quality of fruit that is unsurpassed. We must recognize, however, that other districts have woke up to the fact that the troubles that twenty years ago seemed to be hopeless may be controlled, and not only may be handled, but are being handled in many of the other districts of the United States. The whole fruit growing industry has undergone not a revolution, but an evolution, in the past few years, and while the old farm orchard of the East is a thing of the past many of those places are now making orcharding a business, and through better cultural methods and better care of the trees in the way of pruning, spraying, thinning, etc., are producing fruit that will make a close competitor to the best of our Western fruits. Our growers have sufficient advantages that should enable us to hold the enviable position in the markets of the East that has been secured. It will be necessary, however, for us to use the very best methods that are known to horticultural science from the time the scion graft is made till the apples are placed in the hands of the consumer.

ORCHARD DRAINAGE AND THE NECESSITY OF IT

BY A. H. CARSON, COMMISSIONER THIRD DISTRICT, GRANTS PASS OREGON

THERE are many orchards, already planted and being planted, where the question of drainage has not had the thought and consideration of the planter that it should have to warrant the future success of the orchard. A fruit tree of any kind cannot be planted in wet, cold soil, thrive and be a source of profit. If the land is not naturally drained by a gravel sub-soil that is porous and freely admits the water from winter rains passing through it and draining off below then it should be drained by tiling.

Many of our tree planters take it for granted that our hill slopes are naturally drained because of the grade to the slope when as a matter of fact there are but few hill slopes in Southern Oregon that would not be materially benefited and improved by under draining with tile.

Our hill slopes in Southern Oregon are clay loams, often resting on a stiff clay sub-soil or hardpan from two to three feet below the surface soil. During our winter rains these red clay loams, if resting on a clay sub-soil or a hardpan, hold water in suspension, fill up and the water then flows off over the surface. A wet winter keeps soils of this character filled with water from three to four months during the wet period. A fruit tree planted in such soil has its roots submerged during all the wet period of the year until in many cases the tree is drowned—actually killed. If not killed its vitality is so greatly weakened by the roots being submerged for so long a period that when the growing period arrives it fails to respond, and eventually dies.

The hill slopes of Southern Oregon, from surface indications, look the same—red loam. Their adaptability to the growth of fruit of any kind is a question of depth, and the texture of the sub-soil to facilitate drainage. If the red clay loam soil has a depth of four to more feet, resting on a porous gravel or on decomposed bedrock, then such conditions would insure natural drainage, and such soil could be safely planted to the apple and pear, and would, by thorough cultivation to conserve moisture, give the planter returns for care bestowed. On the other hand, should this red clay loam be from two to three feet in depth, resting on a clay sub-soil, such soil should never be planted to fruit of any kind until under drained. This is a shallow soil, with the water table too near the surface, which would hold water during the wet period, which would drown the tree planted in it. The only way to make these shallow soils available for successful tree growth is by under drainage by tiling. A fruit tree planted in soil of this shallow depth (the water table being but a foot or two below the surface) would not have depth of soil sufficient to anchor itself to sustain the force of a strong wind storm when the ground is saturated with water, as the roots will not penetrate below the water table. Then there is not a depth of soil that would give soil enough for the tree (should it live) to draw nourishment enough to mature a crop of fruit, and it would not be practical, with the best cultivation, to make a tree grow in such a shallow soil, for the reason that soil, being filled with water during the wet period, would not drain off until late in the spring, when the top would bake, and then, if stirred with a plow, heavy clods would form, and it would be impossible to make it fine and create the dust mulch, so necessary to conserve moisture for the growth of the tree during the dry period of the season. Without this dust mulch such shallow soils dry out through capillary attraction to the water table and the tree perishes for the want of moisture.

Where the water table is near the surface these shallow soils, during the wet period, are the wettest soils we have on this Coast and during our dry period are the driest. A soil of this kind can be made available for fruit growing by lowering the water table to four to five feet below the surface by under draining by tiling. By tiling to a depth of four to five feet the winter rains pass through these soils and drain off through the tile. In a year or two this draining off through the soil causes the clay sub-soil to break up, slake and become porous, and to the depth you have laid the tile you have deepened the soil. It takes from two to three years after the tile is laid for all the stiff clay sub-soil to break up and become porous. We under drain shallow soils, and by so doing accomplish a greater depth of soil. We carry off the excess of water that falls during a wet winter through the soil to the drains below. We create a depth of soil that has double the amount of storage of water by absorption that we can conserve for the growing tree by good cultivation, and also a fine dust mulch. By drainage we carry the water through the soil, which is a fertilizer, making it possible for whatever plant food there is in the soil to decay and become soluble for the growing tree, and through the action of the air passing through the soil give the tree the essential gases—oxygen and nitrogen—it must have for a healthy growth.

As paradoxical as it may seem, we tile wet land to make it dry and also to make it wet. This is seemingly contradictory, yet it is a fact. Still it is no more a fact than that our wettest soils during a wet period are our driest soils during a dry period. By tiling we make it possible for air circulation through the tile and through the soil. At the driest period the air at night is always charged with more or less invisible moisture, and by the air circulating through the tile and soil particles condensation occurs because of the difference in temperature, and the moisture is left in the soil for the growing plant. This has been one of our very dry years, and where irrigation could not be had many growing crops have been short, and this shortage is particularly noted on shallow soils. On all soils that have been under drained by tiling it has been observed that crops, both fruit and truck, have grown luxuriantly. The under drained soils have had a continual supply of moisture from condensation that occurs from air circulation through the soil by way of the tile.

Many of our hill slopes that do not require drainage to carry off the water from heavy rains can be made very productive by tiling, so as to create the necessary moisture for growing crops by air circulation through the soil.

Where drainage is contemplated the one who does it must not forget that the deeper the tile is laid the greater area of ground it will drain, and the deeper he has made his soil. Another essential

is grade. Every tile should be laid on grade. In fact where a plot of ground is to be drained it will pay to have the services of a competent civil engineer to lay off the mains and laterals and establish the proper grade. There should be no guess work as to grade. Every tile must be laid on grade or else the purpose of cutting ditches for tile, which is expensive, would be lost. A single tile out of grade would soon fill up and your purpose to drain your land would be defeated.

The expense of under drainage is a factor that perhaps deters many from undertaking it. However, when the benefits derived from under drainage are once understood the time will come when many thousand acres in Oregon will be under drained. In fact the question of irrigation will be one of the factors that will force under drainage, as it is one of the problems of irrigation to get the water to the land and then to run it off, and shallow soils, with a clay sub-soil, cannot be successfully irrigated without under drainage. To emphasize the fact that with general irrigation, which in time will come in Southern Oregon when the benefits are better understood, under drainage will be necessary on many of our soils where the water table is forced near the surface by reason of an impervious clay or cement hardpan sub-soil, I quote Mr. Carl S. Schofield, agriculturist in charge of the Western Agricultural Extension Bureau of Plant Industry, which will be found under the caption, "The Problems of an Irrigation Farmer," in the Year Book of the Department of Agriculture, 1909:

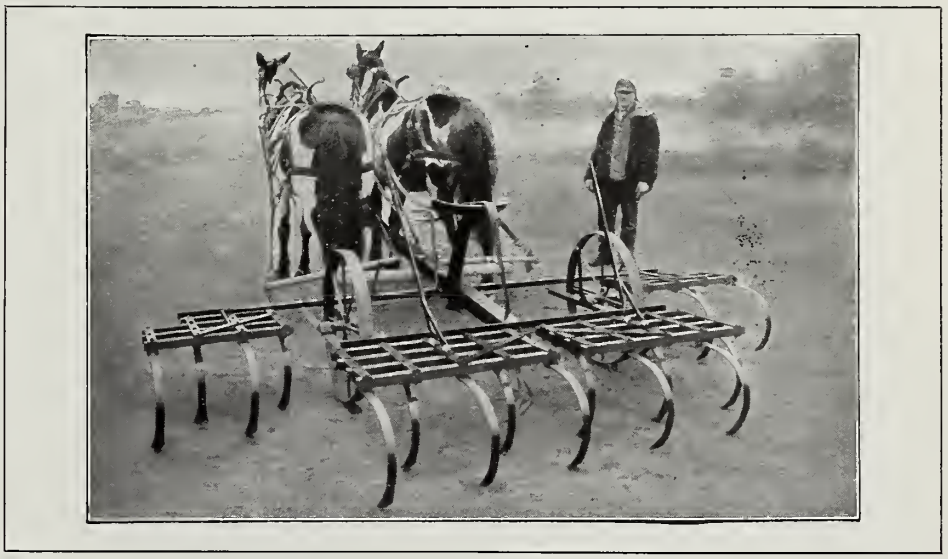
"One of the most striking features in the history of irrigation in the Old World is the ruin of irrigation enterprises caused by the rise of underground water and of alkali. Both in theory and in practice these phenomena are closely associated. Arid lands almost universally contain large quantities of soluble salts, because these salts—the products of rock disintegration and soil formation—are not leached out by rain. The more common salts thus formed are sodium chloride, sodium sulphate and sodium carbonate, and though only the last is really an alkaline salt the popular term 'alkali' is applied to whatever salts occur in the soil water in sufficient quantities to check or prevent plant growth.

"Excessive irrigation, in time, fills the soil with water, in which these salts are dissolved, and the evaporation of the water from the ground brings the salts up and leaves them at or near the surface in constantly increasing quantities. Unless natural drainage courses are present, or artificial ones are created, the inevitable result of excessive irrigation is that the land becomes too wet or too alkaline for the growth of crop plants. This problem of underground waters should be constantly in mind, not only in the selection of an irrigated farm, but also in its management. It does not suffice that a farmer himself uses irrigation water judiciously, for the reckless use of water on adjacent higher land may ruin a farm completely. It is true that either underground waters or alkali alone may cause trouble in some cases, but they occur most frequently together, and both yield to the same remedy, which is adequate drainage."

Irrigated lands where the sub-soil is not porous, with a reckless use of water, soon become swamps. This condition of land becoming swamps is to be found in every irrigation district. From Secretary Wilson's report in the Year Book for 1909 it is estimated that about 700,000 acres of land in the West have become swamps. This land is under water, and the only possibility of reclaiming and making it productive is by under draining by using tile. Any and all contemplated systems of irrigation should have careful surveys made of the sub-soil to determine if the same is porous and will afford the necessary drainage before water is conducted to the land for irrigation or else the promoters may stand to lose large sums of money that an unfavorable sub-soil would defeat were it clay or hardpan.

To put unfavorable land that requires drainage in condition for irrigation the outlay at the beginning is expensive, but in the end the results in production will make it a profitable investment.

When land is once properly drained, with necessary depth, it lasts forever, and with ample water is always productive and gains in richness with each generation for all time.



ORCHARD CULTIVATOR

THIS is the day of the specialist. The proposition that confronts the orchardist of today is that of placing crop production on a sure and permanent basis. He must adopt the most scientific methods. Intensive cultivation is one of the essentials of successful orchard work and holds the key which unlocks the treasure vaults of the soil.

Several years ago, when I went into the peach-growing business in Texas, I realized the need of a light-running cultivator which would work my orchard level and completely mulch and stir the entire surface without disturbing the branches and fruit with the team. I wanted a tool that would reach under the low branches and relieve me of the laborious work with the hoe. I tried many of the best tools made for orchard work, but finding none that met my requirements fully, I set to work on constructions of my own and have built some ten different types of machines within the last four years.

My first triumph was in 1909, when I developed a spring-tooth harrow that would cover eleven feet of surface with one team. This harrow worked admirably and some of my friends thought it to be an ideal orchard tool, but it lacked many features I desired to have involved in an orchard machine. In building this machine I discovered the principle of making a light draft tool and continued my experiments and improvements until April of 1910, when I constructed what is known today as the light draft harrow. This tool has developed more ideal features than I had dreamed and has proven to be a most valuable implement wherever it has been tested.

The harrow is divided into four independent sections, which enables it to conform readily to uneven surfaces, and each section is under easy control of the driver by means of levers,, which enable the operator to lift any one or all of the sections to free them of trash or to pass over obstructions, such as large stones, stumps, etc. All surplus weight is carried on the thirty-inch wheels with very little apparent draft, and the machine is balanced so that no weight is thrown upon the horses' necks, either with or without driver upon the seat. This harrow enables me to cover from twenty to thirty acres of orchard per day with one team of medium weight, and all progressive fruit men recognize the advantage of this rapid work.

The light draft feature of this machine is a surprise to all who have tested it, but it is no longer an experiment, and many large orchardists who were skeptical on this point have been fully convinced after giving it a thorough test. Some of these men who were "doubters" one year ago are now the strongest enthusiasts for the merits of this new orchard tool, and declare it will be the means of revolutionizing the orchard industries of the country.

C. E. Forkner.

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KILLING QUACK GRASS.—A method has been discovered by Mr. P. B. Crane which makes it possible to kill quack grass. We give the formula for the solution used on page 14 of our February, 1911, "Farm Weeds." However, this is not all the information necessary. We should like to give you additional information, but cannot, as the Crane system of quack grass eradication is published in book form by the Webb Publishing Company, St. Paul, Minnesota, and is copyrighted. This book sells for one dollar and we suggest that you purchase it immediately. By purchasing this book you will have full right to use the Crane secret process of killing quack grass. Quack grass can be killed very quickly and with little expenditure. It is necessary to apply the solution in the form of a spray. Spraying machines are needed for this purpose. We refer you to our "Farm Weeds" for information pertaining to same. You can purchase sulphuric acid from your druggest. If you can purchase this in large quantities he should be able to supply you at a reasonable cost. It will give us pleasure to quote you a very low price on sulphate of iron. We shall be pleased to give you any additional information you may want regarding the killing of quack grass or any other weed pests in your locality. Yours truly, American Steel & Wire Co., Chemical and Color Department, Chicago.

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Editor Better Fruit:

I enclose draft for one dollar for renewal of subscription. I think very highly of your specializing each issue; it makes it convenient for reference. Professor O'Gara's article on Pear Blight was worth to me at least much more than the subscription price, and many other articles of like value. Wishing you continued success, yours truly, I. F. Houston, San Juan, New Mexico.

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Editor Better Fruit:

If you can keep up the pace in the character of your paper that you have been going during the past year, your subscribers will certainly get full value for their money. To one contemplating either buying or planting an orchard anywhere your paper is invaluable. Yours truly, S. D. Lieurance, Denver, Colorado.

METHODS OF THE GROWING OF BLACKBERRIES

THERE is perhaps no one fruit so universally grown as blackberries, because none stands so much neglect, and in many sections of the country no pretense is made at cultivating it, as the wild vines or canes spring up in every fence corner and every brush thicket, yielding delicious berries to be had for the picking.

These wild berries have a peculiar flavor or "tang" differing from the cultivated varieties, and on this account are liked better by some people than the latter, while others prefer the garden grown berry. In any event the blackberry is a desirable successor of the raspberry, and the earlier kinds are ripe before the raspberry season is ended. Everyone who has a patch of ground of his own should have some blackberry vines, for the patch, with good care, will continue in bearing year after year for a decade. The new plantation is easily started by taking up the suckers which every year spring up along the rows, or bits of roots three or four inches long may be planted, and these, in a year, make strong plants, ready to be moved to the location desired. It is thus easily seen that choice varieties can be made to multiply very fast. The plants should be set from four to six feet apart in rows eight feet apart.

The blackberry, to succeed well, must be grown on rich, well drained land, and in general these conditions can be secured by thorough cultivation. Naturally, porous, sandy land is ideal if rich in plant food, but moist, rich land, with an excess of nitrogen, will grow too rank canes, which easily winter kill. This can be easily guarded against by application of commercial plant foods, which will balance the excessive nitrogen, and thus increase the bearing capacity of the vines as well as to insure a greater hardiness.

Where the ground is rich in nitrogen, as indicated above, it will pay to apply annually from 250 to 500 pounds of acid phosphate or 300 to 600 pounds of bone meal, and 80 to 160 pounds of muriate or sulphate of potash or 300 to 600 pounds of kainit. The first two will furnish the phosphorous needed and the latter the potash, so essential to profitable fruit growing, whatever the variety may be, the potash giving firmness, and that is a most necessary quality when berries are grown for market that they may keep in good condition in transit. The first year or two cultivated crops can be grown between the rows, but the ground must not be stirred so deep as to cut the roots, else suckers will spring up everywhere and these will make a tangle of vines through which pickers can scarcely find their way when fruiting time comes. To make the gathering of the fruit as easy as possible it is well to confine the plants to the row and drive a stake at intrevals, nailing a wire at each side, thus confining the vines between the wires so they are out of the way and still the fruit can be easily reached from either side. This is a good way to serve raspberries also.

Blackberries grow on the short spurs along the cane, and it is well to pinch off the ends of the canes to encourage the forming of as many spurs as possible. The fruit grows only on wood one year old, and when through bearing for the season the canes should be cut out to give room for new ones which are to bear the succeeding year. Another point, too, is that, if possible, the ground between rows should be mulched heavily just before the fruit is ready to be picked, that it may retain moisture and not be packed too hard by the feet of the pickers. If this is not possible it would be a very good idea to cultivate the patch late in the day after the pickers have gone over it to loosen the soil and conserve the moisture, so as to help in maturing the crop and to make sure of a good yield the succeeding year. There are many good varieties, and the nurseryman will readily advise what kinds are best for certain localities. They will also tell you that orange rust is the only disease of any consequence to be feared, and this can be controlled by spraying with bordeaux mixture, first cutting out and burning all plants showing signs of the disease.—D. C. Cornman, in Colman's Rural World.

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EAT APPLES

By P. Devlin, Penticton, British Columbia

Come, take heed to Doctor Fills,
Eat apples!
Throw away your dopey pills,
Eat apples!
If in chops you must invest,
Though your stomach wants a rest,
Do that which you know is best,
Eat apples!

If you're feeling rather blue,
Eat apples!
When barleycorn has proved untrue,
Eat apples!
Then you'll soon recuperate,
And dodge a most unwelcome fate,
You know it never is too late, if you
Eat apples!

When you go to meet your Eve,
Eat apples!
If she says that you're her Steve,
Eat apples!
She will breathe the fragrant odor
Of sweet pippins in October,
And at least she'll know you're sober,
Eat apples!

Epitaph

Here lies the good old Doctor Fills,
Well he prescribed for all our ills;
Here's hoping that he'll get full mention
At the roll call of the last convention.

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THE price paid for farm produce is determined largely by its condition when delivered to the consumer. The question of transportation was a very serious one a decade ago, inasmuch as the roughly constructed vehicles, which were then used to transport perishable goods to market, were the cause of such a large shrinkage. The farm wagon is one of the oldest and most necessary vehicles in existence. Its greatest improvement during the last twenty years has been in the addition of bolster springs, which make it practically a spring wagon. Farmers in general, in order to obtain the very highest prices for their vegetables, fruits, eggs, etc., are now equipping their wagons with good bolster springs, and have in some cases actually saved the price of a pair of bolster springs in a single load. The Harvey Spring Company, of Racine, Wisconsin, makes a specialty of high grade bolster springs. They are made to fit any wagon and are guaranteed to transform the hardest running farm wagon into an easy riding spring wagon. Farmers interested in securing better prices for their produce should drop a card to the Harvey Spring Company, 784 Seventeenth street, Racine, Wisconsin, and ask for their catalogue and particulars regarding their free trial offer.

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Editor Better Fruit:

Your December number contains a wealth of knowledge. Yours truly, Henry Engel, New York.

GROWING GOOSEBERRIES.—Plant in good rich soil and give a liberal dressing of manure every season. Regular pruning every year is essential for the production of fine fruit. The English varieties, especially, do best in partial shade and should be heavily mulched. To prevent mildew spray the bushes as soon as the leaves appear and also several times during the summer with potassium sulphide, one ounce to four gallons of water. —Exchange.

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Editor Better Fruit:

I received the December number, and will say that if the December number is a fair sample of "Better Fruit" I am sorry that I have not been on your list long ago. Yours for better fruit, Chas. Henderson.

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Editor Better Fruit:

For business purposes I would rather sacrifice all other publications I subscribe to than be without "Better Fruit," as it is the only paper I know of that keeps fruit growers up to date. In fact, I regard it as indispensable. Yours sincerely, W. J. L. Hamilton, South Salt Spring, British Columbia.

SOLVING THE PROBLEM OF THE CODLING MOTH

BY E. P. TAYLOR, GRAND JUNCTION, COUNTY ENTOMOLOGIST AND HORTICULTURAL INSPECTOR OF MESA COUNTY, COLORADO

ONE of the most common questions heard last summer and fall was: "Why do we have so many wormy apples? Is it the spray, or what is the matter?"

Many have expressed their opinions as to the cause, and I might repeat the conclusions I have formed, with an idea of pointing out ways we may improve our conditions another year.

In the first place I do not think that the quality of the arsenate of lead used this season by our Grand Valley growers was at fault in the main. As evidence of this it may be cited that at least half a dozen different brands of arsenate of lead were used throughout the valley, and, with a few exceptions, comparisons failed to indicate that this was the source of the trouble. I do not wish to convey the idea that all arsenates of lead are the same, and that it is not of greatest importance each season for growers in purchasing them to make sure of both their total arsenic content and the amount of free arsenic which will cause burning. There were individual failures in spraying in this valley last season, just as there have been in other seasons, from lack of thoroughness, disregard for the timing of sprays in relation to the life history of the moth, insufficient hand and power spray outfits to cover the orchards at the proper times and poor kinds of spray pump accessories. I do not think that these details were neglected any more this year, proportionately, than in the five years preceding, for they have always been the bugaboos of the ones who have been placed in the position of advisers to fruit growers in matters of codling moth spraying.

Then why has the loss from codling moth been greater this year than in some years before? The principal explanation seems to lie in the superabundance of worms this year, due to several natural causes. A combination of these natural conditions made codling moth life very easy the past season, so easy in fact that the moth proved a winner in many cases against spraying methods which had won the battle for growers in previous years.

A high percentage of the hibernating larvae came through the winter of 1909-10 alive, perhaps due, as some have suggested, to a cold winter, with even instead of varying temperatures. The freezing and thawing conditions are more destructive to hibernating larvae, it is thought, than a prolonged and even winter temperature, even though very cold.

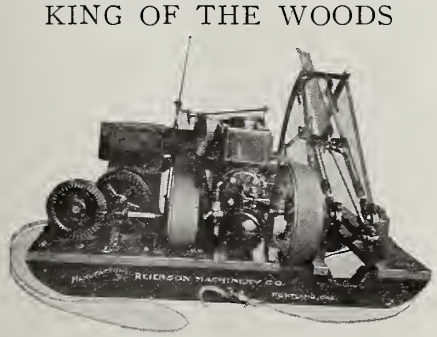
Adding still more to the odds of the moth a comparative light crop of fruit prevailed in many orchards, thus concentrating the attack, and, as a final handicap for the worms, the season of their breeding was hot and dry, almost beyond precedent (a condition that is most favorable for their multiplication). The mean monthly temperatures for May, June and July, 1810, exceeded these months for the five preceding years.

As a result of the natural conditions favoring the moth, eggs were deposited and worms hatched during the season in numbers exceeding any record ever made of this pest before. I have, for a number of years in codling moth work, made systematic observations in the orchards for the eggs, and the enormous increase in numbers of eggs encountered this season was very apparent. Five years ago, in this valley, when my observations were kept up for over three months, about 1,000 eggs were tabulated. This year had an attempt been made to record the eggs seen I am afraid I would have been yet engaged, with a goodly clerical force, footing up the totals. Just as an example of a few counts made this season the following may be given from my notes of August 25 in an orchard which had been sprayed. The eggs were found with but a few moments' search either upon the fruit itself or upon the leaves or twigs about it. Many of the empty shells had possibly been washed or blown away before counting, but the following still remained: Two Winesaps, 48 eggs and shells; one Jonathan, 52; one Winesap, 14; one Jonathan, 61; two Jonathans, 108; one Jonathan, 57.

About the eight apples at least 340 codling moth eggs had been deposited, or an average of 42 eggs per apple. Under such conditions is it strange that a few worms should have escaped even the most thorough sprayers? One worm biting through the skin out of the 42 eggs makes a specked apple and one into the flesh a wormy apple. As a result of such an onslought of codling moth, here is what happened in a few unsprayed orchards.

On June 18, in an unsprayed Ben Davis orchard, 97.2% of the apples still upon the trees were already wormy by the first brood worms, with an average of more than three worm holes per apple. On the same day counts made in an unsprayed Winesap orchard gave 96.6% wormy, and a third unsprayed orchard on July 1 gave 96.8% wormy, both including only the fruit still upon the trees. In the last case the average worm holes per apple was more than three. These three instances cite the damage done by first brood worms alone.

In the season of 1906 the writer, under the direction of Professor Gillette, conducted very extensive spraying experiments in four separate orchards of the Grand Valley, detailed records being tabulated at the end of the season involv-



ing the critical inspection of more than 100,000 apples, representing upwards of 600 bushel boxes. A full report of that work has never been published, but a brief summary was issued by me in Bulletin 119 of the Colorado Agricultural Experiment Station in February, 1907, from which I quote my conclusions as to the number of sprays necessary: "The number of sprays required to control the moth in an orchard will depend principally upon (1) previous infestation of orchard, (2) proximity to other infested orchards, (3) efficiency of earlier sprays and (4) variety of fruit." Although in the G. W. Marchant orchard at Fruita that year 98% Winesap and 95.6% Ben Davis were secured with only two sprays, it was stated in the bulletin quoted, that in common practice there would be more than this number of sprays necessary, and consequently a table was given for the use of fruit growers suggesting approximate times for five sprayings each year, if that many became necessary. In the summer of 1907, while still connected with the office of the Western Slope Fruit Investigations for the State Agricultural College, I carried on another season's codling moth spraying experiments in Hill Bros'. orchard on Orchard Mesa, at that time securing 96.5% perfect fruit with two sprays against the first brood and one against the second, and 97.3% with all three sprays against the first brood.

After several additional years' experience in codling moth spraying, and especially after the past year's observations in this valley, I am more than ever convinced that my conclusions as published five years ago were correct, and that it is folly for anyone to state arbitrarily the exact number of sprays necessary under all conditions to control codling moth. Statements to the effect that one or two sprays will control codling moth in any section under all conditions to me denote that they are based upon observations too limted or upon experiments with insufficient range of conditions. The sweeping claims that have been made as to the possibilities of the one-spray method for codling moth control have been misleading in that they were not properly qualified as to conditions. Bulletin No. 127, which was recently received from the West Virginia Experiment Station, states that the Western one-spary method gave 97.4% apples free from worm injury, but it is of interest to note that only 34% of the apples became wormy throughout the season in unsprayed orchards. A recent bulletin from the United States Department of Agriculture gives some results in controlling codling moth by a single spraying, the experiments being undertaken as a result of the claims for the one-spray method. These recent government experiments were conducted in Arkansas, Virginia and Michigan, and although from 84% to 93.6% perfect fruit were secured, it is interesting to note that worms were not particularly abundant, as shown by the statement that the percentage of perfect fruit for the whole season in orhcards where no spraying at

all was done ran 66.7% in the Arkansas orchards, 53% and 54% in the Virginia orchards and 77.79% in the Michigan experiment.

My own recommendations for the past season in the main were for five sprays, as indicated from time to time in spray warnings, 'phoned to growers or published in local papers, and even this number of sprays under conditions prevailing last year were inadequate to control the worms, although some good results were secured the past season with five sprays.

We may be confident that favorable natural causes, such as parasites, together with the good we are able to do by working bands, scraping the rough tree trunks for the destruction of larvae in the spring, thinning wormy fruit, etc., will give us many seasons in which three sprays will be sufficient, but we will all agree with the fruit grower, who, in reply to the query as to the number of sprays he is going to give, says, "Spray as many times as it takes to kill the worms."

I am a firm believer in the importance of the first, or calyx cup spray. In Western Colorado it has certainly been far more important in the past five years than any one other spray applied. Every experiment conducted in this valley has taught this lesson most emphatically,

A knowledge of the life history of the moth has taught us that the reason for filling the calyx cup with poison is the fact that a high percentage of first brood worms enter the blossom end of the fruit. Seasons vary, however, as to percentage entering the calyx end of the unsprayed apples. In my work at Fruita a few years ago about two-thirds of all wormy fruit was wormy at the calyx in unsprayed orchards, yet by proper spraying the first time the calyx worm holes were reduced to practically none.

This year, on June 18, while only first brood worms were present, 201 apples were picked from an unsprayed Winesap, 192 being wormy. Of the 192 wormy apples 133 were wormy at the calyx, or 69%, and 176 were wormy at the side or stem, or 91.6%. These 176 side and stem wormy apples, however, bore 351 worm holes, and only 27½% of all worm holes were calyx holes. On the same day 88.9% of the total wormy Ben Davis on unsprayed trees on another place were wormy at the calyx, but the side worms were so much more abundant than the calyx holes that they only rep-

resented 25.7% of the total. Again, on July 1, on unsprayed Black Ben out of 122 wormy apples, all from the first brood, 86% were wormy at the calyx, while 90% of these apples were also wormy from the side or stem. The total number of worm holes in these 122 apples was 379, so the percentage of calyx injuries was but 27.7% of the total.

These instances are cited not to show that a very high percentage of the unsprayed fruit do not become wormy at the calyx and that the filling of the calyces is not imperative, but it is my purpose to show that entirely too high a percentage of worms, even of the first brood, enter at the sides of the fruit to hope to control codling moth with a calyx spray only in a year of abundant worms. It is also important to keep the sides of the forming apples coated with poison for the destruction of those first brood worms which do not enter at the calyx. The calyx spray is applied before the apple is formed, and can surely serve little purpose in coating over the sides of the apple, then only the size of a pea. Some may urge that it is possible to destroy worms which hatch and first feed upon the leaves, since the leaves are usually fairly well unfolded, though not completely so, at the time of the calyx spray and are, therefore, partially coated with poison. Although the higher per cent of the earliest eggs are laid upon the upper sides of leaves while the apples are still fuzzy, during the last half of the egg-laying period of first brood moths, which comes after the fruit has become smooth upon the sides, a high per cent of the eggs are laid upon the fruit. Does it not seem entirely improbable that very many worms hatching from eggs on the fruit would leave the fruit and go to the leaves to take their first meal?

Editor Better Fruit:

Yesterday I wrote you in regard to my subscription, fearing you did not receive my remittance. I am pleased to say in today's mail I got the finest fruit paper I have ever seen. It is a container of inspiration of the great Northwest, surely, and I hope to have the pleasure of meeting you personally in the near future. Yours truly, Victor Dewein, Warrensburg, Illinois.

Editor Better Fruit:

I beg herewith to enclose a check from my friend, Mr. H. E. Houston, for which please send him a year's subscription to "Better Fruit." Knowing when I have a good thing, I push it along. Yours truly, Guy Seaton, Spokane Bridge, Washington.

Editor Better Fruit:

Your December number of "Better Fruit" was worth a year's subscription. Yours respectfully, Philip Gibbons, Freewater, Oregon.

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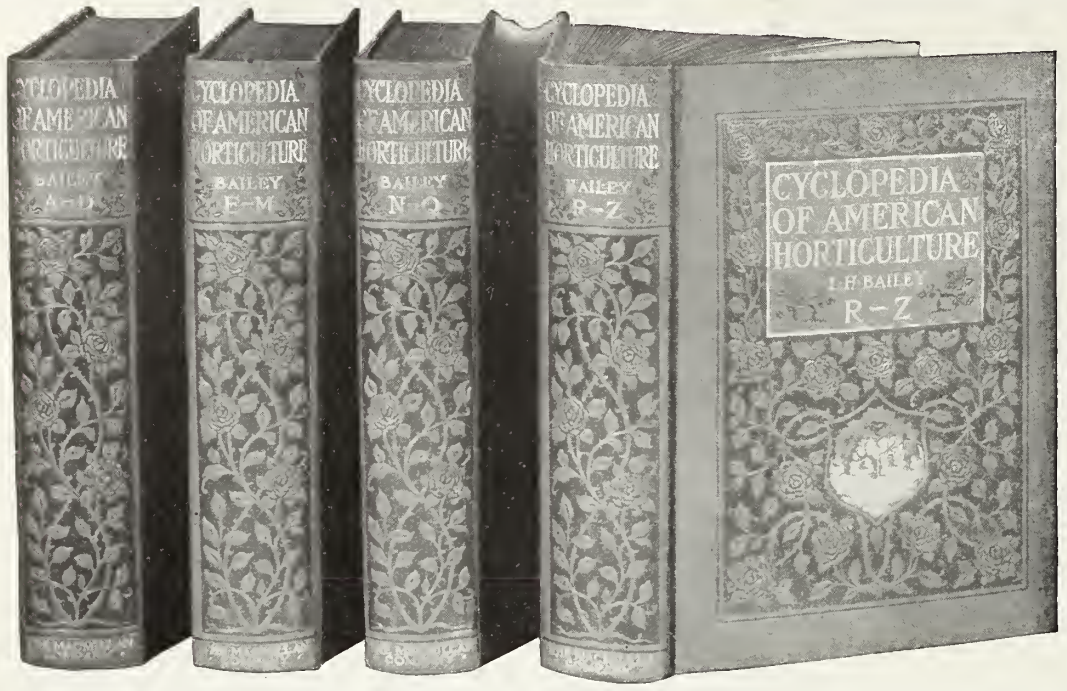

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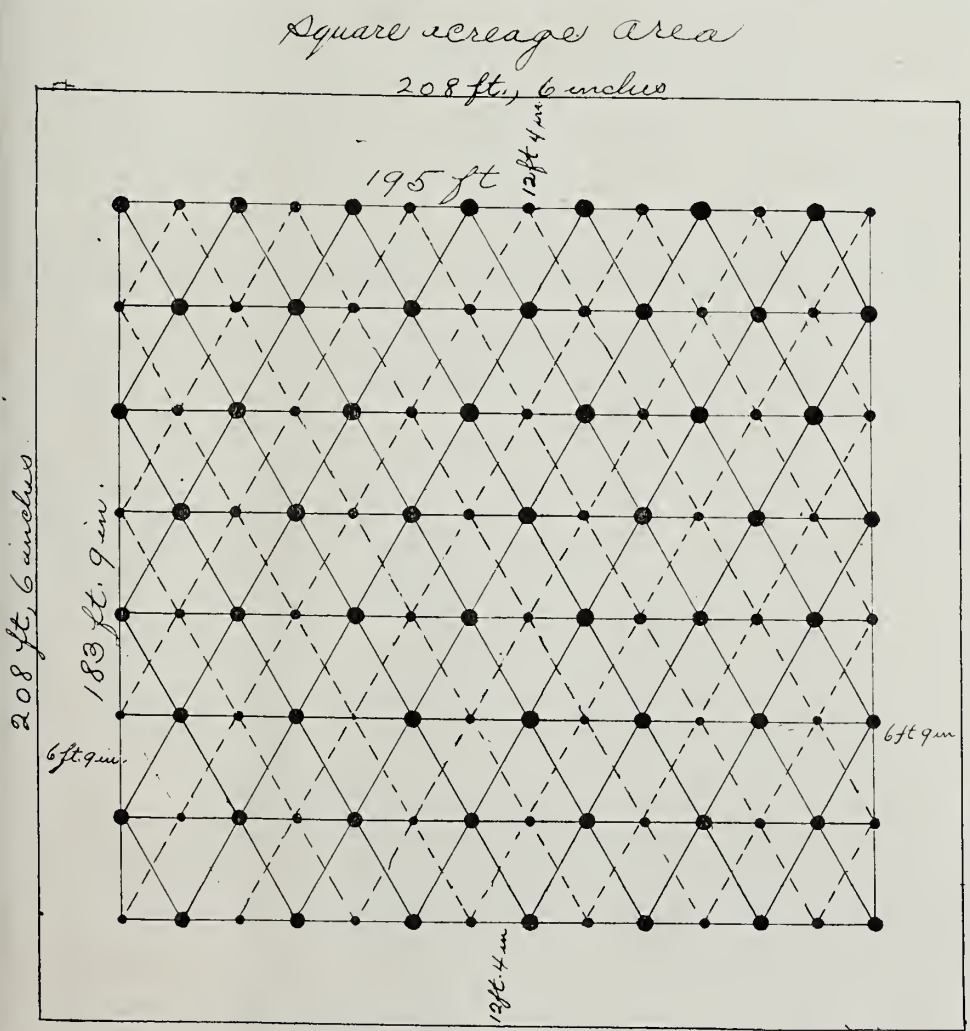
BETTER FRUIT PUBLISHING CO., Hood River, Oregon

HINTS ON HEXAGONAL SYSTEM OF TREE PLANTING

BY F. J. RUPERT, SALEM, OREGON

AFTER looking over the various hints on tree planting by the square and hexagonal, triangular systems, it occurred to the writer that the latter system might be placed before the planter in a way which would give him a clear and concise idea of just how to lay off his land, either in setting out one or more acres of apples, pears, etc., and provide him with information as to the exact number of permanent trees and fillers required. The article by W. H. Lawrence in the December number of "Better Fruit," together with the illustrations, is truly of value to the planter who desires to adopt the square method of planting permanent and filler trees, as it shows exactly the number of trees per acre and distance apart of permanent trees as well as distance of fillers from the permanent trees, viz.: Permanent trees thirty feet apart each way, seven rows of trees, seven trees to the row—total forty-nine permanent trees per acre. Fillers in center of each square of four permanent trees, 19½ feet from permanent trees, allowing 36 fillers, or a total of 85 trees per acre. Also, on page 28 of the same issue, Mr. Edward G. Merwin describes to a certain extent the method of planting by the hexagonal system, showing small diagrams to illustrate the same, also giving information relative to thinning, but there is an absence of illustration to show acreage planting, number of trees, both permanent and fillers, which will be shown by the accompanying diagram.

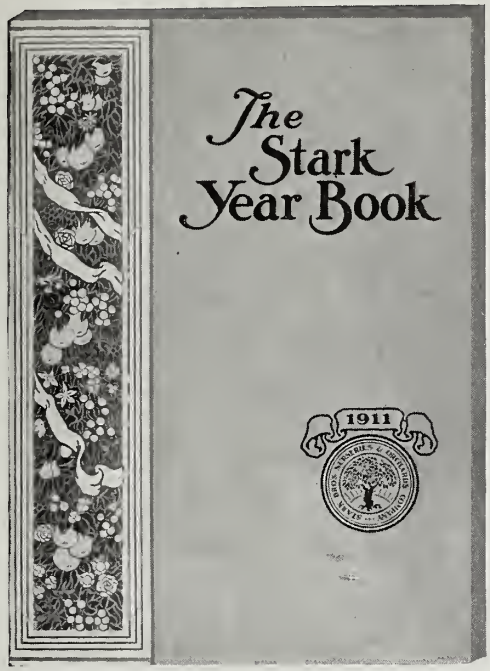


Here is shown a plat representing an area of 195x183 feet 9 inches, or approximately 42,997 square feet. It will be observed that the width of the area is the greater. We will presume that one acre is to be set in apples. Commence at a point 12 feet 4 inches below and 6 feet 9 inches to the right of upper left-hand corner and set stake for first permanent tree. Thirty feet to the right of this stake set stake for second permanent tree, and so on until seven stakes have been set thirty feet apart, crosswise of the area in a straight line, as shown by the large dots, which represent the permanent trees. Then measure down from a point midway between two first permanent trees 26 feet 3 inches and set first stake for permanent tree of second row. Measuring from this point to the first or second permanent tree diagonally the distance will be thirty feet. Then to the right thirty feet set stake for second permanent tree of second row, and so on across the area. Proceed according to the diagram until you have set stakes for eight rows of seven trees each. Here, instead of having 49 trees thirty feet apart as in the square method of planting, you have 56 trees, each thirty feet apart, a gain of seven trees within the acre area. It is largely the rule with planters in setting out a young orchard, by way of economy in the land, to plant what are known as fillers, or some other variety of fruit, such as peaches, between the permanent trees. Dwarf pears may also be used, they occupying less space than the larger or standard varieties. We will presume

that peaches are used for fillers. They come into bearing earlier than apples or pears, and also some other fruits, and several crops may be harvested while the permanent trees are coming into full commercial bearing. So long as the fillers do not crowd the permanent trees or render cultivation, pruning, etc., difficult they may remain in the orchard, and produce an income from the spare ground space. When they do begin to crowd the permanent trees by way of obstructing the free inlet of sunlight, or interfere in any way with the proper care of the permanent trees, they may be removed, but they will have paid for themselves many times over before it becomes necessary to remove them.

By further reference to the diagram it will be seen that there are smaller dots between the larger ones. Each small dot represents a filler tree. The fillers thus set will be fifteen feet distant from the nearest permanent tree. In this case the same number of fillers may be used as permanent trees, or 56. The total number of trees to the acre will thus be 112 instead of only 95 by the common square method of planting.

As aforesaid, it is presumed that one acre is being thus planted. As there are approximately 208½ feet on the sides and ends of an acre square of land, in setting the trees within an area of 195x183 feet 9 inches, as shown by the diagram, there will be a margin on both sides of 6 feet 9 inches, and on both ends of approximately 12 feet 4 inches.



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These additions to The Stark Year Book have quite naturally delayed its date of issue a trifle—from January 15th to February 1st—but its readers will be well repaid for the slight delay. More than ever, The Year Book becomes a complete volume of the most helpful and practical guidance to the orchardist and fruit grower.

Two special features of The Stark Year Book deserve special mention. Where practicable, we have appended to our own descriptions, made from first-hand experience and close observation, the experience and observation of many other horticulturists. We have thus hoped to give to them that degree of definiteness and accuracy which is possible only when a description stands side by side with the weightiest possible evidence in support thereof.

We have also tried earnestly to meet many another practical difficulty of the beginner as well as of the more experienced—in a word, afford him the opportunity of getting what will be the best of all aids to success—a condensed knowledge of the whole subject.

If you have not already sent for your copy of The Stark Year Book for 1911 do so at once—fill in and send us the coupon today. Postage 10 cents. The demand for Volume II is tremendous; the edition is limited, and probably will not be reprinted when exhausted.

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SOME METHODS OF GROWING FRUIT IN FRANCE

From the Oregon Journal

NOW has come the season of the year when week-end visitors hear nothing but discussions of the state of the garden at the homes of their amateur farmer friends. The only questions of importance are whether "our corn" will be good, or "our raspberries" as fine as last year.

According to the impression obtained by week-end visitors people sit up nights with their potato crop and cannot sleep for anxiety over the tomatoes. There is no doubt about it that American amateur farmers take their rural avocations very seriously. When a Frenchman fell to discussing the other day what he had seen on his trips about the country, however, he expressed amazement at the lack of attention to detail.

"In this country," he said, "you just put things in the ground and let them grow more or less haphazard, as far as I can see. You have a soil so fertile that I suppose you can dispense with much that is necessary in our old country. But all the same I think the fruit might be benefited if you did some of the things that every French grower does. France is the country of detail, you know, and we think it pays in fruit growing just as it does in cooking.

"The fruits we pet and pamper most are the peach and grape. The majority of peaches grown in this country would seem, to a Frenchman, to be distinctly of the second order, that is, in the language of his fruit culture, a peach 'de plein vent,' or one grown on trees in an orchard. Between peaches grown thus, 'open to the wind,' and those trained on trellises against walls the French make a sharp distinction.

"The trellis, of 'espalier,' peaches are the only ones that appear on a carefully regulated table, and are universally cultivated. They always command a much higher price than the tree peach, and at Montreuil the fruit has been brought to such perfection that they habitually sell for from forty to eighty cents apiece.

"Even more elaborate is the procedure with fine table grapes. Hothouse grapes are not highly in favor among French epicures, for they are held to lack the rich flavor of the fruit grown in the open. At the same time the grape is so much in demand as a table delicacy that it is desirable that their season should be prolonged as far as possible into the winter. The difficulty of this situation has been met by a system which, complicated as it is, is quite generally in use.

"The grapes are grown on trellises exposed to the sun and six or seven yards apart, like the peaches. When the clusters are ripe they are put with the stem and leaves in a sort of glass box or bottle, which is placed in a dark room. If the producer is growing for

the market the bunches are looked at every day, for the slightest speck of imperfection will keep him from disposing of his stock to the best houses.

"The same care in lesser degree runs through all the French grower does. In certain places, but only in a few, the apricot is treated with all the care shown to the peach. It is less profitable to grow, for it does not keep well, except by an expensive process of coating it with wax. The trees, however, are kept very carefully pruned and the production of each is limited.

"Growers have a pleasant way with strawberries. This berry's flavor is, as everybody knows, more or less injured by washing, but in this country they sometimes become so dirty that there is no alternative for the careful housekeeper. In France they are never specked with earth, because every grower spreads straw neatly under his vines so that the rain can splash up no dirt, nor the wind blow any dust on the delicate fruit. The result is a strawberry as clean as a cherry on its tree.

"Gooseberries and raspberries are raised in quantities for the English market, the former trimmed very low, sometimes 'cradle-shaped,' and the latter trained on wire fences, facing not the sun, but the north.

"All these are the common customs of our country, founded on our national love of perfection in detail. There is another form of careful fruit growing, less sensible and much restricted, on which we can hardly pride ourselves,

WHEN WRITING ADVERTISERS MENTION BETTER FRUIT

though it shows to what extent art can be applied to the production of luxuries.

"Growers can at once retard fruit and dwarf trees to such an extent that it is possible to purchase during the winter fruit actually growing on little trees small enough to be served, pot and all, on the table. Peaches thus grown (one on a tree only) cost about twenty dollars apiece, other things in proportion, and the fruit is usually sold not to French people, but to visitors with more money than discretion, who think it smart to imitate what they consider the luxury of our gay capital.

"All this care of detail may seem absurd to you who have a country so large and so lavishly productive as America. Still I think it is an open question whether even here, where 'time is money,' so much more than it is in Europe, the expenditure of care and thought on some neglected details might not lead to the financial profit of some growers."

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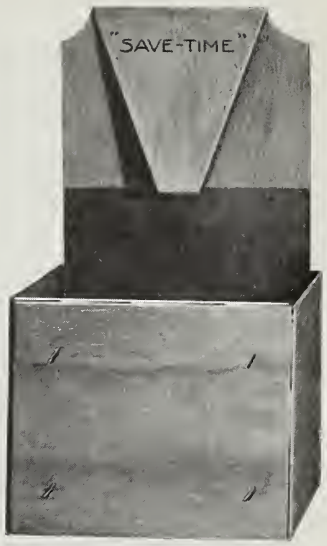
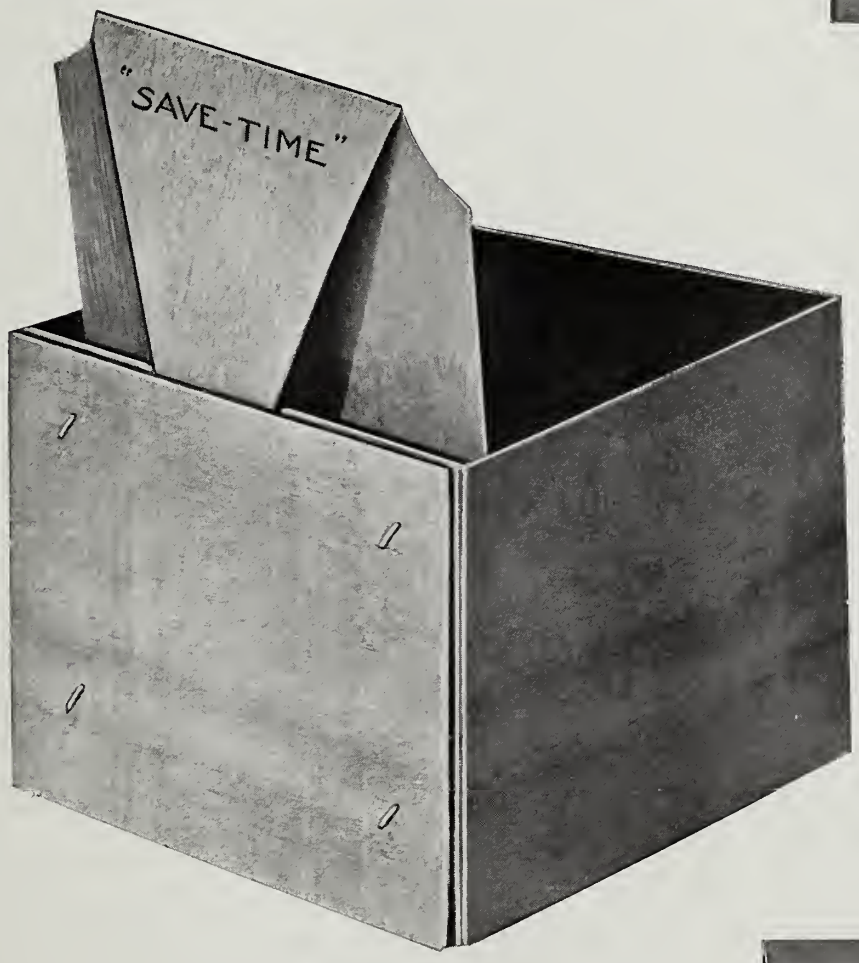


AS IT OPENS



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WHEN YOU
NEED IT

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IT IS SO EASY

PACKED
THREE BUNDLES
TO A
THOUSAND

ASK YOUR
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OUR AGENTS
OR US AND DO IT
EARLY

EASILY MADE UP

NO BREAKAGE
OR WASTE

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LIVING ON THE LAND, SUCCESSFUL FARMER'S WIFE

From the Des Moines Capital

SO far as success goes the wife of a farmer in the western part of the State of Iowa tells a very good story. It is a story of success at farming. With her husband, she paid for some of the land as high at $45 per acre. It is another case where constant work and the proper kind of economy won out. In a letter from Ogden, Iowa, to the Capital, "A Farmer's Wife" says:

"In September, 1892, sixteen years ago, my husband, then a young Illinois man 26 years of age, started northwest to seek a home. Going first to Minnesota, from which state he turned with apparent disgust, returning to Central Iowa, where he secured an eighty-acre farm with a three-room cottage and small stable for $2,800, paying down $1,000, money he had saved from his wages as farm hand, and giving a mortgage on the land for $1,800 for five years at eight per cent.

"In the spring of 1893 we were married and came to Iowa to live on this farm. Starting in with two good horses, a plough and harrow, wagon and corn planter, two cows, one dozen chickens, we went to work with a determination to win. The first year we did some tilling, built a cellar, plastered and painted our cottage, bought some machinery, paid our interest and had $100 to pay on principal. In the fall of 1895 we purchased another forty acres adjoining the original eighty, paying $42.50 an acre, or $1,700.

"At the close of the year we always pay all of our debts, our taxes and interest, and always have a snug sum to pay on principal, making it a point to pay the cash for everything we buy, so far as possible. We are firm believers in the motto, 'Pay as you go and then you won't owe.' Have never run a store bill to exceed $10. It is so much easier to pay for an article when you get it than after it is gone.

"The spring of 1898 found us free from debt, with some money on hand, so we bought another 120-acre farm, paying $45 an acre, which we have paid for by working hard and keeping everlastingly at it. This farm we have always rented out at $3 and $3.25 an acre.

"In 1901 we purchased another forty, paying $70 an acre, which we have paid for by close farming, raising horses, cattle and hogs to sell, milking from five to eight cows, raising about 200 chickens a year. We have never kept a hired man, preferring to do the work alone. In busy seasons I often help do light work in the field, such as raking hay, plowing with riding plow, and picking corn; work that I find healthful as well as profitable, having never been sick a day. I think it is a wife's duty to help meet as well as help eat, and in return the 'better half' helps me wash and churn.

"In 1905 we purchased another eigthy-acre tract, adjoining the first two named purchases, making us a lovely 200-acre home farm, paying $70 an acre, with no improvements. This farm we have improved by building an addition to our house, a $1,000 barn, three wells and windmills and other buildings, besides laying 10,000 tile on the different farms.

"We have been very busy, but still have found time to make seven trips to

Illinois to visit home folks. We do not find it necessary to work on Sundays, as some do, but find it a pleasant recreation to drive to the village church, three miles away, or rest quietly in our own home, reading good books or papers, among them the Daily Capital. We are contented and happy. I have not endeavored to tell of hard times or misfortunes that have come to us, as will come to all, preferring to look on the bright side of life and strive on, not forgetting that the things of the world are only temporal, but 'lay up for yourselves treasures in heaven, where moth or rust doth not corrupt nor thieves break through and steal.'

"We are at present preparing to move to a small farm near town to educate our children. I have endeavored to state facts as they occurred to us, hoping someone may be benefited thereby and determined to secure a home, for what two have done surely others may."

◈ ◈ ◈

Almost the whole world knows of Hood River as a place that produces the best fruits, and all of Hood River Valley should know, and could know, that there is one place in Hood River, under the firm name of R. B. Bragg & Co., where the people can depend on getting most reliable dry goods, clothing, shoes and groceries at the most reasonable prices that are possible. Try it.

◈ ◈ ◈

Editor Better Fruit:
I can't keep house without "Better Fruit." Yours truly, F. A. Schlick, Rockford, Illinois.

THE UNKNOWN SNOUT BEETLE OR BUD WEEVEL

BY GEORGE CHASE, MANAGER MODEL ORCHARD, PROSSER, WASH.

THIS pest seems to be practically unknown to "bug men" of the Northwest. It was first brought to my notice in the spring of 1909, and was found on some peach trees in the Grandview, Washington, Orchard Tracts. Some of the beetles were sent to Pullman, and Professor Melander called them "bud weevil," and recommended using an inverted umbrella in shaking the tree over, the old method of catching the plum curculio; but as these come when there is no foliage on the trees they see you before you get close enough for this, and, generally speaking, I don't think they have been very bad so far, but in the spring of 1910, in early March, they attacked every tree (over sixteen thousand) in the Model Orchard. This orchard is set to apples and pears alternately, and we were about through pruning the apples when they begun working on them, so we did not prune the pears, and they were not damaged much. We first painted all the trees (all one year old) with very strong arsenate of lead, but found it did no good; then we tried rex, and that did no good, because they eat very little of the surface, but eat a hole into the bud and then gouge out the heart of the bud, completely destroying it. In the meantime it seemed as if every apple tree was doomed; we were not able to get any advise that helped, and it was from reading an article in

"Better Fuit" on "Woolly Aphis" that I got a nudge "if kerosene emulsion would kill woolly aphis why would it not kill the snout beetle?" Happy thought, but I had never used kerosene emulsion, and did not know how to make it, and here is where I must take off my hat to Professor Melander, because he had compiled and published in the spray number of "Better Fruit" the spray calendar, and from this I learned how to make the emulsion (10 per cent), and we began applying it. The effect was sure and speedy. We used one-half gallon funnel measures, capped over so as to leave an opening about the size of a match, pouring a small quantity on the ground around the trees, as the beetle is not able to burrow, but lives in the holes and entrances around the body of the tree. One application was found to be enough. There were from a dozen to fifty to a tree.

The beetle is ash-color, about one-third of an inch long, has six legs, a long snout with two feelers on it, and will be found around the trunk of the tree in early March; it is not seen after April 15th; works only when the weather suits him, likes smoky weather best, eats nights as well as day times, but goes into the ground if it is too hot or too cold. So far I have found the snout beetle on one-year-old trees on ground second year after clearing from sage brush.

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WAY TO MEASURE WATER.—The quantity of water running in a large or small stream or in a ditch can be measured very simply without the use of a weir, if an approximation of the flow will suit the purpose. First secure the mean velocity in feet per minute, by throwing a floating body such as a light straw or thin stick of wood into the center of the stream, where, of course, the water is flowing the fastest. The stick should be thrown some distance above the point to be measured, so that by the time it gets down it will have acquired the velocity of the water. Measure off fifteen or twenty feet, and take the time consumed by the stick in going this distance. This velocity is much more than the mean velocity of the stream. In fact, take 83 per cent of this velocity as the average. Next secure the cross section by getting the average depth, which can be found by measuring the depth in a number of places at equal distance across the stream, adding them together and dividing by the number of measurements taken. This will give the average depth, which should be multiplied by the width of the stream at the surface for the cross section. Thus if it is found that the float traveled twenty feet in ten seconds, then the stream is flowing two feet per second. If you desire to be more exact, take 83 per cent of this velocity. Then multiply by the cross section and you will have the cubic feet per second.—Exchange.

LATE WATERING TREES.—Trees transpire water in the winter the same as they do in summer, but not to so great an extent, of course, as when the trees are in full leaf and in an active state of growth. The gist of the whole matter is simply this: If the ground becomes dry during the winter the trees will be very apt to be injured by the tops becoming dried out. This is one of the principal causes of the so-called freezing dry, a common occurrence in the northern part of Colorado. As a general thing it may be said that late watering is advisable, because the rule will apply in the majority of cases. But it is with irrigation as with most other orchard operations—no set rules can be given; the orchardist must determine these points for himself. If the orchard soil is inclined to hold water, obviously more water will be a detriment. In some cases that we have seen, drainage would be better practice. In other orchards the ground will become very dry, all of which the grower can easily determine, and then he should regulate his practice accordingly.—W. Paddock, Colorado Agricultural College, Fort Collins.

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Editor Better Fruit:

Your beautiful publication came to us today. It is a credit not only to your section of the country, but to the whole country. Yours very truly, Emory C. Cook, Baltimore, Maryland.

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Editor Better Fruit:

Enclosed please find my check for one dollar for "Better Fruit." I feel that it is the most satisfactory one dollar that I spend during the year. If I could get as much in return for every dollar invested, Easy street would certainly have a large mansion, with my nameplate on the door. Sincerely yours, J. R. Weatherbee, Portland, Oregon.

Editor Better Fruit:
The January number has been received. It is a beauty. Yours truly, C. W. Wilson, Canastota, New York.

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Editor Better Fruit:
I value your paper very highly and each issue is carefully read. Wishing you continued success, I am, sincerely, A. B. Ballantyne, St. George, Utah.

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Editor Better Fruit:
Your Apple Show number is one of the most attractive specials I have seen and speaks well not only for your enterprise and equipment, but for the territory you serve so well.—J. W. McEachren, Editor of the Northwestern, Chicago.

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Editor Better Fruit:
Enclosed find one dollar for your magazine. It is far too good to do without and is a great credit to the fruit business of the continent. I should like to feel that it was going into the hands of every fruit grower in Canada and the United States. Your last number was certainly a beautiful production and you Oregon men deserve great credit for the degree of perfection you have attained in growing fruit. Wishing you further success for the future, faithfully, Ralph S. Eaton, Kentville, Nova Scotia.

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Editor Better Fruit:
I have read today the January edition of "Better Fruit." I have been reading your magazine for over two years and it is one of the most attractive and valuable journals that come to my desk, and the January number is a little the best I have seen. —Sincerely yours, H. M. Cottrell, Agricultural Commissioner Rock Island Lines, Chicago.

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Editor Better Fruit:
Enclosed find one dollar for yearly subscription to your wonderful paper. Fruit grower or not, I wouldn't be without it for many times its price. I have only been in the fruit business about a year and a half. I take three other fruit papers, and I must say that I have gotten more real information out of "Better Fruit" on picking, packing and all subjects relating to orchard management than from all the others put together. Yours very truly, Richard H. Clemmer, Middlebrook, Virginia.

Editor Better Fruit:
I have taken "Better Fruit" for three years and consider it the best to be had. Yours truly, R. J. Arnold, Council Bluffs, Iowa.

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Editor Better Fruit:
I think "Better Fruit" is an excellent paper, the best of its kind that I have read. It is certainly a great help to the fruit grower and every one should include it in his list. Wishing you success, I am, yours truly, Charles Bell, Delta, Colorado.

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Editor Better Fruit:
The Bureau of Manufactures of Washington, D. C., informs you that the director of a government experimental fruit station in a European country has requested an American consular officer to supply him with the names of manufacturers in the United States of machinery used in preparing fruit for conservation. Firms interested in this line may secure the name and address of the person to whom correspondence should be addressed by writing to this office and referring to foreign trade opportunity No. 5,798.—Respectfully, A. H. Baldwin, Chief of Bureau.

Editor Better Fruit:
As a lover of fruits, as well as a prospective producer, I want to congratulate you on the success you are making. You certainly deserve the support of all progressive fruit growers. With best wishes, R. D. Allen, Salem, Oregon.

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Editor Better Fruit:
Your January number is certainly a hummer. If you keep on there is no doubt but what "Better Fruit" will be the "Country Life in America" of the West. With best wishes, believe me, A. F. Nagle, Assistant Manager "Advertising and Selling," New York.

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Editor Better Fruit:
By yesterday's mail I received our copy of January "Better Fruit," and I cannot let it alone. I knew you were preparing a rather elaborate edition, but this one lays it all over any previous attempts, in my opinion, for artistic work and for thoroughness on the various articles. You have certainly boosted the National Apple Show to a finish. Your plan of writing up all of the Western shows in one issue was a dandy, and you have no idea how valuable this issue will be to us as a reference work. Throughout our campaign people are always asking for some information concerning other shows and wanting to know about some of the features. By having this issue at hand we can show them so much that it will be invaluable to us.—Sincerely, Ren H. Rice, Secretary Spokane National Apple Show.

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Editor Better Fruit:
Believing it would be of interest to the readers of "Better Fruit" in general, as well as myself, I write to ask that, if it is not incompatible with the policy of your publication, an article or discussion be published in a future issue pertaining to the following: (1) Are chickens injurious to the growth of fruit trees and the production of fruit on those trees, if allowed the run of the orchard? If so, at what times and in what manner? (2) Are chickens beneficial to the growth of fruit trees and the production of fruit on those trees, if allowed the run of the orchard? If so, at what times and in what manner? (3) Would the effects of chickens be different in the commercial orchard and the home orchard? If so, at what times and in what manner? It is desired that the monetary value of chickens and their products be absolutely barred from consideration in connection with the above; the effect on quantity and quality of fruit being the only thing considered. The above is respectfully submitted in the absence of knowledge as to whether or not similar matter has previously been printed in "Better Fruit."—W. E. Smith, 519 Kosciusko street, Jacksonville, Illinois.

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Editor Better Fruit:
Through the kindness of Dr. A. E. Kline we are in receipt of several copies of your most excellent publication, "Better Fruit," and have enjoyed the perusal of the interesting articles contained therein. The illustrations are exceptionally good and very nicely arranged. We also sampled one of the apples you brought with you and can truly say that we never have eaten better and probably nowhere near so good. Hood River Valley certainly has them all beat for prime apples, and we also note that the growers are getting wise to the marketing end of the business as well as growing the fruit. With the proper climate and soil, good varieties, thorough knowledge of packing, and organization in marketing, the fruit business is getting on a basis that means prosperity for the industry. You people have about solved these problems. Was sorry I did not meet you when you were here, but hope the next time you pass through you can find time to call. Thanking you, and with best regards, I remain, yours very truly, L. H. Woodworth, Editor Sutter County Farmer, Yuba City, California.

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Editor Better Fruit:
We certainly want to congratulate you on the exceedingly splendid number of the January or Apple Show edition of "Better Fruit." This is without doubt the banner number of any fruit magazine ever published and you should feel more than proud of your efforts. Yours truly, Missoula Chamber of Commerce, Missoula, Montana.

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Editor Better Fruit:
Have just received the Apple Show number and it is a beauty. Yours very respectfully, Jay P. Green, Corvallis, Oregon.

POTASH NOT REQUIRED.—The Geneva, New York, experiment station concludes after several years' work that orchard soils in that section do not require potash. It is evident that the element is not only present in the soil, but in sufficient quantity and available. This is also the case in the volcanic ash soils east of the Cascade range, but not so in the Coast section, where rains have leached the potash for centuries, so that the chemist does not find it in sufficient amount for good fruit crops. The berry growers here find by actual experiment that judicious applications of potash for a series of years increases production of berries, besides giving them more firmness for shipping, than where they are deprived of this element. They are preparing to utilize the potash in the liquid manures from their stables; they will buy wheat for egg production, preserving the fertility for the berry fields, and in addition are purchasing muriate of potash salts.—Bellingham Herald.

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We take pleasure in advising the trade that for the third consecutive time practically the entire crop of this noted valley has been purchased by us, consisting of the noble NEWTOWN PIPPIN, the delicious SPITZENBERG, the magnificent GOLDEN ORTLEY and such other varieties as grow to perfection only in the Hood River Valley.

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